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02

Chevron

Phil Howard
General Mine Manager

Chevron Mining Inc.
Questa Mine
PO Box 469
3 1/2 Miles E of Questa on SR 38
Questa, NM 87556
Tel 575-586-7521
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Phillip.Howard@chevron.com

Expiration 9/30/11

March 29, 2011

RECEIVED
BY "6WQ-NP" DATE APR 1 2011

Isaac Chen
USEPA, Region 06
1445 Ross Ave
Dallas, TX 75202-2733

Re: Chevron Mining, Inc. – Questa Mine
NPDES permit NM0022306 renewal

Dear Mr. Chen:

Enclosed is the completed renewal application for NPDES permit NM0022306 for Chevron Mining Inc.'s Questa Mine, as well as additional supporting information to assist in developing new permit limits and monitoring requirements for discharge at Outfall 002. Supplemental information being submitted in support of this application includes:

- Supplemental Information and Water Quality Data Analysis for Chevron Mining Inc., NPDES Permit Renewal Application (GEI 2011c). This includes:
  - a water quality data analysis of effluent constituents as measured during the current permit cycle, as well as a reasonable potential analysis based on these data
  - a recommendation to abandon the 001 outfall
  - a recommendation to allow operational flexibility through cessation of a pumpback system with its flow added to 002
- Evaluation of Best Management Practices and Storm Water Management (ARCADIS 2011)
- Summary of Red River Biological Monitoring Data, 2002 through 2010, in the Vicinity of NPDES Permitted Outfall 002 (GEI 2011b)
- Red River Aquatic Biological Monitoring Report 2010 (GEI 2011a)

The intent of this information is to assist in your understanding and evaluation of CMI's existing Best Management Practices (BMPs) and storm water management at the mine and tailing facility, as well as the associated water quality and biology of the Red River in the vicinity of the

10 4 2 6 1 1

mine and tailing facility. A thorough evaluation of the data should provide you with the information you need to properly assess the issues related to the permit renewal.

One important issue we would like to bring to your attention is that the numeric criteria for several metals have changed as a result of the state of New Mexico Water Quality Control Commission's triennial review of water quality standards in 2010. Of particular significance to the NPDES renewal is that the ambient water quality criteria for aluminum and cadmium have changed, with a significant change for aluminum. Both criteria are now hardness based, so for the Red River in the vicinity of the mine, the acute aluminum criteria increased approximately 6 times and the chronic criteria approximately 20 times, while the chronic cadmium criteria nearly doubled. In addition, water quality criteria for both manganese and molybdenum have now been established; prior to the 2010 hearing there were no criteria for these two metals. New Mexico has adopted these new criteria effective December 1, 2010 (NMWQCC 2010) and EPA is expected to likewise adopt them following their technical review. As these are the most recent and scientifically appropriate water quality criteria available for New Mexico, these criteria would be most appropriate for use in the permit renewal.

One of the questions that has been raised by EPA is whether a hydraulic connection exists between the tailing facility and the Red River through the groundwater system and what impact does such a connection have on water quality in the river. To the extent that there may be a hydraulic connection at the tailing facility, it is being addressed through the implementation of BMPs. The combination of what is already being done at the tailing facility, and the actions required by the ROD, will achieve at least a BMP-level of control to protect the quality of the river. This conclusion is supported by the extensive studies which have been done at the mine site and tailing facility as part of the CERCLA Remedial Investigations (RI). These studies should provide sufficient information to assess the hydraulic connection and the effectiveness of existing and planned measures to address that connection. These studies are summarized in the attached report by ARCADIS (2011). Please note, also, that the ARCADIS report has been updated since our meeting in February. The update includes more recent water quality data from the Red River collected in early March 2011, reflecting the best information on current conditions adjacent to the tailing facility.

Chevron Mining has implemented storm water controls and water management at the mine site through a Storm Water Pollution Prevention Plan (SWPPP). These Best Management Practices (BMPs) are in place to reduce the hydraulic connection with the river. BMPs include groundwater extraction wells at the base of the roadside rock piles and two seepage interception systems along the northern river bank (ARCADIS 2011), which are documented and described in the previous NPDES permit and fact sheet. Loading analyses in the RI found that these BMPs remove constituent loads that are equivalent to or greater than the constituent loads produced by the rock piles. These analyses were used by EPA as supporting documentation in the previous NPDES renewal. In December 2010, the EPA issued the Record of Decision (ROD) for the Questa Mine that that contains a number of remedial measures that are explicitly intended to prevent or mitigate the impact of hydraulic connections on the Red River.

In addition, the water quality of the Red River has improved along the mine site in recent years, indicating that the BMPs and other water management systems are working to prevent impacts from the mine operations to the river. There have been decreasing trends in constituent concentrations observed in the Red River at the downstream boundary of the mine. When aluminum concentrations in the Red River are compared to the new 2010 chronic aquatic life criterion, there has not been an aluminum exceedance in the river since 2008.

Biological monitoring in the vicinity of the mine is described in detail in the Red River Aquatic Biological Monitoring Report 2010 (GEI 2011a). Overall, resident trout populations and invertebrate populations in the Red River indicated that there were three areas of impact as measured by decreased abundance. These areas are 1) downstream of the Town of Red River, 2) downstream of Hot-n-Tot and Hansen Creeks, and 3) downstream of Capulin Canyon. The first two areas are upstream of the mine, and the third area is downstream of the mine boundary. The impacted trout and invertebrate populations in these areas are primarily the result of poor water quality and sediment input from naturally occurring hydrothermal alteration scars and upwelling groundwater. All three areas are located downstream from hydrothermal scars. The hydrothermal scars generate acidic metal-laden runoff and increase sediment loading of the river, thereby affecting fish and invertebrate populations. The fish and invertebrate populations in the Red River adjacent to the mine property demonstrate some recovery from the measured levels at the site immediately upstream of the mine property. This indicates that if any hydraulic connection is occurring in the vicinity of the mine property, it does not appear to be negatively affecting the stream biota.

The tailing facility also has a tailing seepage interception system in place to reduce any hydraulic connection to the Red River (ARCADIS 2011). The seepage system at the tailing facility includes seepage barriers and extraction wells that collect seepage from the impoundment and the eastern flank of Dam No. 4. The seepage system also collects seepage from Dam No. 1; however, this impoundment is now dry and is no longer receiving process water from the mine. There was earlier evidence of pipeline leakage in the seepage system. However, in 2010 CMI lined the Outfall 002 discharge pipeline, and replaced other system pipelines, decreasing potential leakage to the groundwater system. EPA's selected remedy in the ROD includes enhancements to the seepage interception system, which will further reduce the potential for hydraulic connections between the tailing impoundments and the river.

Tailing seepage may occur at the Dam No. 4 impoundment, but this seepage has not resulted in exceedances of any numeric groundwater standards, and any seepage impacts are sufficiently monitored by wells and springs between the impoundment and the Red River. In fact, most all constituents in the river along the tailing facility decrease in concentration, with the exception of molybdenum, sulfate, and total dissolved solids, which are due to the permitted 002 discharge. The further decrease in concentrations of these parameters in the Red River downstream of Outfall 002 indicates that even if there were a hydraulic connection with the river, seepage from the tailing facility does not degrade the river's quality – and, in fact, may further dilute instream concentrations.

Biological monitoring in the vicinity of the tailing impoundments demonstrates no measureable adverse effects when comparing sites upstream and downstream of Outfall 002 (GEI 2011b). Fish population data indicate that overall mean biomass and density were greater at the two sites downstream of Outfall 002 than upstream. Similar results were found for benthic invertebrate data, in which density and number of taxa were greater at the downstream sites than the upstream sites. These data indicate that neither Outfall 002, nor any seepage occurring from the tailing facility (including Dam 4), are causing degradation of the water quality in the Red River, as biological populations downstream of the tailing facility are doing as well as or better than populations upstream.

Overall there are no point or non-point discharges from the mine site or tailing facility that have resulted in an exceedance of numeric surface water criteria or appear to have caused any negative impacts to the biology of the Red River. Thus, should any hydraulic connection of the mine site or tailing facility to the Red River occur, such a connection does not cause any particular constituent to exceed water quality criteria. Furthermore, the ROD issued by the EPA in December 2010, addresses and should further reduce any potential hydraulic connections between the Questa Mine and the Red River.

Please contact Armando Martinez, 575-586-7639 or amarti@chevron.com if we can be of any further assistance in your evaluation of this permit application.

Sincerely,

Phil Howard
General Mine Manager

Enclosures

Cc: NMED SWQB

REFERENCES

ARCADIS U.S. Inc. 2011. *Evaluation of Best Management Practices and Storm Water Management, Questa Mine and Tailing Facility, Questa, NM.*

GEI Consultants, Inc. (GEI). 2011a. *Red River Aquatic Biological Monitoring Report 2010.* Report prepared for Chevron Mining Inc. Questa, NM.

GEI Consultants, Inc. (GEI). 2011b. *Summary of Red River Biological Monitoring Data, 2002 through 2010, in the Vicinity of NPDES Permitted Outfall 002* Technical memo prepared for Chevron Mining Inc. Questa, NM.

GEI Consultants, Inc. (GEI). 2011c. *Supplemental Information and Water Quality Data Analysis for Chevron Mining Inc., NPDES Permit Renewal Application* Technical memo prepared for Chevron Mining Inc. Questa, NM.

New Mexico Water Quality Control Commission (NMWQCC), 2010. Hearing Officer's Report WQCC 08-13, IN THE MATTER OF THE PETITION TO AMEND 20.6.4 NMAC - STANDARDS FOR INTERSTATE AND INTRASTATE SURFACE WATERS

Please print or type in the unshaded areas only. Approved. OMB No. 2040-0086.

FORM 1 GENERAL	EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY **GENERAL INFORMATION** *Consolidated Permits Program* *(Read the "General Instructions" before starting.)*	I. EPA I.D. NUMBER
			S: F; NM0022306; T/A: ; C: D

LABEL ITEMS		GENERAL INSTRUCTIONS
I. EPA I.D. NUMBER	PLEASE PLACE LABEL IN THIS SPACE	If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, cross through it and enter the correct data in the appropriate fill-in area below. Also, if any of the preprinted data is absent *(the area to the left of the label space lists the information that should appear)*, please provide it in the proper fill-in area(s) below. If the label is complete and correct, you need not complete Items I, III, V, and VI *(except VI-B which must be completed regardless)*. Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.
III. FACILITY NAME		
V. FACILITY MAILING ADDRESS		
VI. FACILITY LOCATION		

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of **bold-faced terms**.

SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED
A. Is this facility a **publicly owned treatment works** which results in a **discharge to waters of the U.S.**? (FORM 2A)		X	
B. Does or will this facility *(either existing or proposed)* include a **concentrated animal feeding operation** or **aquatic animal production facility** which results in a **discharge** to **waters of the U.S.**? (FORM 2B)		X	
C. Is this a facility which currently results in **discharges** to **waters of the U.S.** other than those described in A or B above? (FORM 2C)	X		
D. Is this a proposed facility *(other than those described in A or B above)* which will result in a **discharge** to **waters of the U.S.**? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of **hazardous wastes**? (FORM 3)		X	
F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)		X	
H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed **stationary source** which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	
J. Is this facility a proposed **stationary source** which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an **attainment area**? (FORM 5)		X	

III. NAME OF FACILITY

1 SKIP CHEVRON MINING INC. -QUESTA MINE

IV. FACILITY CONTACT

A. NAME & TITLE *(last, first, & title)*	B. PHONE *(area code & no.)*
2 MARTINEZ, ARMANDO - Senior Environmental Specialist	(575) 586-7639

V. FACILTY MAILING ADDRESS

A. STREET OR P.O. BOX

3 P.O. BOX 469

B. CITY OR TOWN	C. STATE	D. ZIP CODE
4 QUESTA	NM	87556

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

5 3.5 mi. east of Questa on S.R. 38

B. COUNTY NAME

TAOS

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE *(if known)*
6 N/A	NM	87556	

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

A. FIRST		B. SECOND	
7 1061	(specify) Metal Mining - Ferroalloy Ore	7	(specify)

C. THIRD		D. FOURTH	
7	(specify)	7	(specify)

VIII. OPERATOR INFORMATION

A. NAME: 8 CHEVRON MINING, INC.

B. Is the name listed in Item VIII-A also the owner? ☑ YES ☐ NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box: if "Other," specify.)

F = FEDERAL
S = STATE
P = PRIVATE
M = PUBLIC (other than federal or state)
O = OTHER (specify)

P (specify)

D. PHONE (area code & no.): A (575) 586-7637

E. STREET OR P.O. BOX: P.O. BOX 469

F. CITY OR TOWN	G. STATE	H. ZIP CODE
B QUESTA	NM	87556

IX. INDIAN LAND

Is the facility located on Indian lands? ☐ YES ☑ NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water): 9 N NM0022306	D. PSD (Air Emissions from Proposed Sources): 9 P
B. UIC (Underground Injection of Fluids): 9 U	E. OTHER (specify): 9 (specify)
C. RCRA (Hazardous Wastes): 9 R NMD002899094	E. OTHER (specify): 9 (specify)

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers, and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS (provide a brief description)

Mining and milling operations producing Molybdenum Disulfide concentrate

XIII. CERTIFICATION (see instructions)

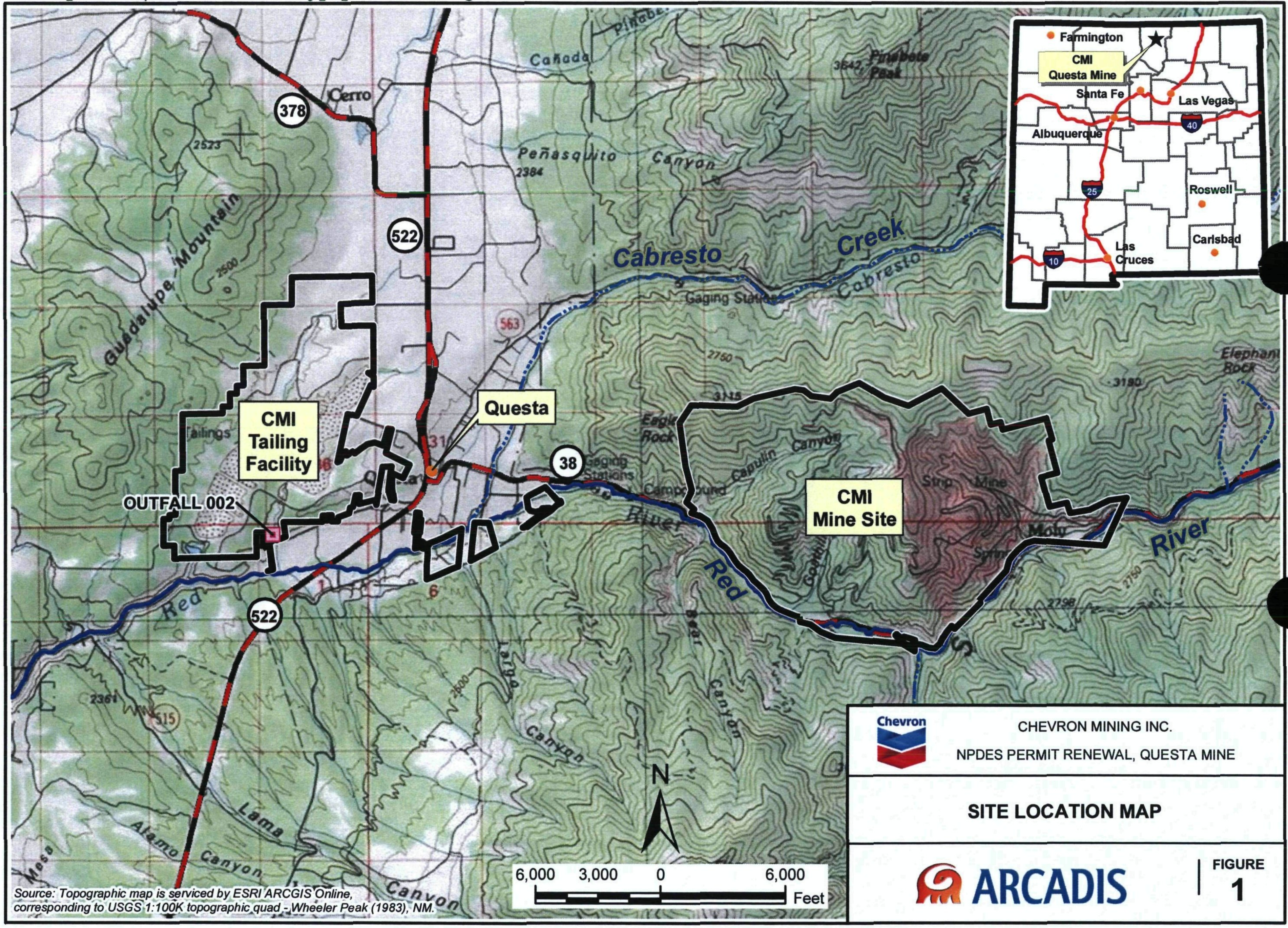
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
Phil Howard, General Mine Manager	Phil Howard	3/29/11

COMMENTS FOR OFFICIAL USE ONLY

C

CITY: Boulder, CO DRAFTER: JC
Project (Project #): CO001337
K:\CO001337_CMI\GIS\ArcMaps\2011 NPDES Permit Renewal\Fig1_site_location.mxd - 3/25/2011 @ 9:53:50 AM



CHEVRON MINING INC.
NPDES PERMIT RENEWAL, QUESTA MINE

SITE LOCATION MAP

FIGURE 1

Please print or type in the unshaded areas only.

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)
NM0022306

Form Approved.
OMB No. 2040-0086.
Approval expires 3-31-98.

FORM **2C** NPDES

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER
EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURE OPERATIONS
Consolidated Permits Program

I. OUTFALL LOCATION

For each outfall, list the latitude and longitude of its location to the nearest 15 seconds and the name of the receiving water.

A. OUTFALL NUMBER (*list*)	B. LATITUDE			C. LONGITUDE			D. RECEIVING WATER (*name*)
	1. DEG.	2. MIN.	3. SEC.	1. DEG.	2. MIN.	3. SEC.	
002	36.00	41.00	31.36	105.00	37.00	16.58	Red River

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES

A. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item B. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined (*e.g., for certain mining activities*), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

B. For each outfall, provide a description of: (1) All operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and storm water runoff; (2) The average flow contributed by each operation; and (3) The treatment received by the wastewater. Continue on additional sheets if necessary.

1. OUT-FALL NO. (*list*)	2. OPERATION(S) CONTRIBUTING FLOW		3. TREATMENT		
	a. OPERATION (*list*)	b. AVERAGE FLOW (*include units*)	a. DESCRIPTION	b. LIST CODES FROM TABLE 2C-1	
002	Seepage from tailing facility and	0.645 MGD	no treatment		
	native groundwater.				

OFFICIAL USE ONLY (*effluent guidelines sub-categories*)

CONTINUED FROM THE FRONT

C. Except for storm runoff, leaks, or spills, are any of the discharges described in Items II-A or B intermittent or seasonal?

☐ YES (*complete the following table*) ☑ NO (*go to Section III*)

1. OUTFALL NUMBER (*list*)	2. OPERATION(s) CONTRIBUTING FLOW (*list*)	3. FREQUENCY		4. FLOW				
		a. DAYS PER WEEK (*specify average*)	b. MONTHS PER YEAR (*specify average*)	a. FLOW RATE (*in mgd*)		B. TOTAL VOLUME (*specify with units*)		C. DURATION (*in days*)
				1. LONG TERM AVERAGE	2. MAXIMUM DAILY	1. LONG TERM AVERAGE	2. MAXIMUM DAILY	

III. PRODUCTION

A. Does an effluent guideline limitation promulgated by EPA under Section 304 of the Clean Water Act apply to your facility?

☑ YES (*complete Item III-B*) ☐ NO (*go to Section IV*)

B. Are the limitations in the applicable effluent guideline expressed in terms of production (*or other measure of operation*)?

☐ YES (*complete Item III-C*) ☑ NO (*go to Section IV*)

C. If you answered "yes" to Item III-B, list the quantity which represents an actual measurement of your level of production, expressed in the terms and units used in the applicable effluent guideline, and indicate the affected outfalls.

1. AVERAGE DAILY PRODUCTION			2. AFFECTED OUTFALLS (*list outfall numbers*)
a. QUANTITY PER DAY	b. UNITS OF MEASURE	c. OPERATION, PRODUCT, MATERIAL, ETC. (*specify*)	

IV. IMPROVEMENTS

A. Are you now required by any Federal, State or local authority to meet any implementation schedule for the construction, upgrading or operations of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

☑ YES (*complete the following table*) ☐ NO (*go to Item IV-B*)

1. IDENTIFICATION OF CONDITION, AGREEMENT, ETC.	2. AFFECTED OUTFALLS		3. BRIEF DESCRIPTION OF PROJECT	4. FINAL COMPLIANCE DATE	
	a. NO.	b. SOURCE OF DISCHARGE		a. REQUIRED	b. PROJECTED
Permit NM0022306 Part II.A. requires continued operation and maintenance of BMP's			seepage interception system - see attached supplemental information	n/a	n/a

B. OPTIONAL: You may attach additional sheets describing any additional water pollution control programs (*or other environmental projects which may affect your discharges*) you now have underway or which you plan. Indicate whether each program is now underway or planned, and indicate your actual or planned schedules for construction.

☒ MARK "X" IF DESCRIPTION OF ADDITIONAL CONTROL PROGRAMS IS ATTACHED

 CONTINUE ON PAGE 3

CONTINUED FROM PAGE 2

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)
NM0022306

V. INTAKE AND EFFLUENT CHARACTERISTICS

A, B, & C: See instructions before proceeding – Complete one set of tables for each outfall – Annotate the outfall number in the space provided.
NOTE: Tables V-A, V-B, and V-C are included on separate sheets numbered V-1 through V-9.

D. Use the space below to list any of the pollutants listed in Table 2c-3 of the instructions, which you know or have reason to believe is discharged or may be discharged from any outfall. For every pollutant you list, briefly describe the reasons you believe it to be present and report any analytical data in your possession.

1. POLLUTANT	2. SOURCE	1. POLLUTANT	2. SOURCE
Uranium 39.6 ug/L - sample collected 12/13/2010 Vanadium 1.38 ug/L - sample collected 12/13/2010 Strontium 2.2 mg/L - sample collected March 2008	naturally occurring		

VI. POTENTIAL DISCHARGES NOT COVERED BY ANALYSIS

Is any pollutant listed in Item V-C a substance or a component of a substance which you currently use or manufacture as an intermediate or final product or byproduct?

☐ YES (*list all such pollutants below*) ☑ NO (*go to Item VI-B*)

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VII. BIOLOGICAL TOXICITY TESTING DATA

Do you have any knowledge or reason to believe that any biological test for acute or chronic toxicity has been made on any of your discharges or on a receiving water in relation to your discharge within the last 3 years?

☑ YES (*identify the test(s) and describe their purposes below*) ☐ NO (*go to Section VIII*)

Required testing per NPDES Permit NM0022306, Outfall 002.

Test date	Ceriodaphnia dubia		Fathead minnow	
	Survival	Reproduction	Survival	Growth
3Q 2007	no effects	no effects	n/a	n/a
4Q 2007	no effects	no effects	no effects	no effects
1Q 2008	no effects	no effects	no effects	no effects
2Q 2008	no effects	no effects	no effects	no effects
3Q 2008	no effects	no effects	no effects	no effects
4Q 2008	no effects	no effects	no effects	no effects
1Q 2009	no effects	no effects	no effects	no effects
2Q 2009	no effects	NOEC 12%, IC25 >48%	no effects	no effects
3Q 2009	no effects	no effects	no effects	no effects
4Q 2009	no effects	no effects	NOEC 24%, IC25 42.7%	no effects
1Q 2010	no effects	NOEC 6%, IC25 6.9%	no effects	no effects
4Q 2010	no effects	no effects	n/a	n/a

VIII. CONTRACT ANALYSIS INFORMATION

Were any of the analyses reported in Item V performed by a contract laboratory or consulting firm?

☑ YES (*list the name, address, and telephone number of, and pollutants analyzed by, each such laboratory or firm below*) ☐ NO (*go to Section IX*)

A. NAME	B. ADDRESS	C. TELEPHONE (*area code & no.*)	D. POLLUTANTS ANALYZED (*list*)
ALS Laboratory Group	225 Commerce Drive, Ft. Collins, CO 80524	970-490-1511	all routine analytes
Hall Environmental Analysis Laboratory	4901 Hawkins NE, Suite D, Albuquerque, NM, 87109	505-345-3975	additional analytes as needed

IX. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. NAME & OFFICIAL TITLE (*type or print*)	B. PHONE NO. (*area code & no.*)
Phil Howard, General Mine Manager	(575) 586-7521
C. SIGNATURE Phil Howard	D. DATE SIGNED 3/29/11

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY. You may report some or all of this information on separate sheets (*use the same format*) instead of completing these pages.
SEE INSTRUCTIONS.

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)
NM0022306

V. INTAKE AND EFFLUENT CHARACTERISTICS (*continued from page 3 of Form 2-C*) [redacted]

OUTFALL NO.
002

PART A –You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

1. POLLUTANT	2. EFFLUENT							3. UNITS (*specify if blank*)		4. INTAKE (*optional*)		
	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
a. Biochemical Oxygen Demand (*BOD*)	<2.0		NA	NA	NA	NA	1	mg/l		NA	NA	NA
b. Chemical Oxygen Demand (*COD*)	7.04		NA	NA	NA	NA	1	mg/l		NA	NA	NA
c. Total Organic Carbon (*TOC*)	1.3		NA	NA	NA	NA	1	mg/l		NA	NA	NA
d. Total Suspended Solids (*TSS*)	NA	NA	<4	20.52	<4	15.42	12	mg/l	lbs/d	NA	NA	NA
e. Ammonia (*as N*)	<0.43		NA	NA	NA	NA	1	mg/l		NA	NA	NA
f. Flow	VALUE NA		VALUE 0.645 MGD		VALUE 0.472 MGD		36	NA	NA	VALUE NA		NA
g. Temperature (*winter*)	VALUE NA		VALUE NA		VALUE NA		NA	°C		VALUE NA		NA
h. Temperature (*summer*)	VALUE NA		VALUE NA		VALUE NA		NA	°C		VALUE NA		NA
i. pH	MINIMUM NA	MAXIMUM NA	MINIMUM 6.59	MAXIMUM 7.79	[redacted]		36	STANDARD UNITS		[redacted]		

PART B – Mark "X" in column 2-a for each pollutant you know or have reason to believe is present. Mark "X" in column 2-b for each pollutant you believe to be absent. If you mark column 2a for any pollutant which is limited either directly, or indirectly but expressly, in an effluent limitations guideline, you must provide the results of at least one analysis for that pollutant. For other pollutants for which you mark column 2a, you must provide quantitative data or an explanation of their presence in your discharge. Complete one table for each outfall. See the instructions for additional details and requirements.

1. POLLUTANT AND CAS NO. (*if available*)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. BELIEVED PRESENT	b. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
a. Bromide (24959-67-9)		X												
b. Chlorine, Total Residual		X	<0.05						1	mg/l				
c. Color		X												
d. Fecal Coliform		X												
e. Fluoride (16984-48-8)	X		NA	NA	1.3	5.39	1.12	4.25	12	mg/l	lbs/d	NA	NA	NA
f. Nitrate-Nitrite (*as N*)	X		<0.41		NA	NA	NA	NA	1	mg/l		NA	NA	NA

ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NO. (*if available*)	2. MARK "X" a. BELIEVED PRESENT	2. MARK "X" b. BELIEVED ABSENT	3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION	3. EFFLUENT a. MAXIMUM DAILY VALUE (2) MASS	3. EFFLUENT b. MAXIMUM 30 DAY VALUE (*if available*) (1) CONCENTRATION	3. EFFLUENT b. MAXIMUM 30 DAY VALUE (*if available*) (2) MASS	3. EFFLUENT c. LONG TERM AVRG. VALUE (*if available*) (1) CONCENTRATION	3. EFFLUENT c. LONG TERM AVRG. VALUE (*if available*) (2) MASS	3. EFFLUENT d. NO. OF ANALYSES	4. UNITS a. CONCEN-TRATION	4. UNITS b. MASS	5. INTAKE (*optional*) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION	5. INTAKE (*optional*) a. LONG TERM AVERAGE VALUE (2) MASS	5. INTAKE (*optional*) b. NO. OF ANALYSES
g. Nitrogen, Total Organic (*as N*)		X												
h. Oil and Grease		X												
i. Phosphorus (as P), Total (7723-14-0)	X		53.3		NA	NA	NA	NA	1	ug/l		NA	NA	NA
j. Radioactivity														
(1) Alpha, Total	X		30.1		NA	NA	NA	NA	1	pCi/L		NA	NA	NA
(2) Beta, Total	X		7.06		NA	NA	NA	NA	1	pCi/L		NA	NA	NA
(3) Radium, Total	X		<0.994		NA	NA	NA	NA		pCi/L		NA	NA	NA
(4) Radium 226, Total	X		<0.696		NA	NA	NA	NA		pCi/L		NA	NA	NA
k. Sulfate (*as SO_4*) (14808-79-8)	X		1100		NA	NA	NA	NA	1	mg/l		NA	NA	NA
l. Sulfide (*as S*)	X		<0.1		NA	NA	NA	NA	1	mg/l		NA	NA	NA
m. Sulfite (*as SO_3*) (14265-45-3)	X		<0.5		NA	NA	NA	NA	1	mg/l		NA	NA	NA
n. Surfactants		X												
o. Aluminum, Total (7429-90-5)	X		NA	NA	0.25	0.802	0.007	0.022	36	mg/l	lbs/d	NA	NA	NA
p. Barium, Total (7440-39-3)	X		25.8		NA	NA	NA	NA	1	ug/l		NA	NA	NA
q. Boron, Total (7440-42-8)	X		31.0		NA	NA	NA	NA	1	ug/l		NA	NA	NA
r. Cobalt, Total (7440-48-4)		X	1.05						1	ug/l				
s. Iron, Total (7439-89-6)	X		82		NA	NA	NA	NA	1	ug/L		NA	NA	NA
t. Magnesium, Total (7439-95-4)	X		79		NA	NA	NA	NA	1	mg/l		NA	NA	NA
u. Molybdenum, Total (7439-98-7)	X		NA	NA	1.8	6.22	1.48	5.60	12	mg/l	lbs/d	NA	NA	NA
v. Manganese, Total (7439-96-5)	X		NA	NA	0.51	1.99	0.40	1.57	36	mg/l	lbs/d	NA	NA	NA
w. Tin, Total (7440-31-5)		X												
x. Titanium, Total (7440-32-6)		X												

 CONTINUE ON PAGE V-3

CONTINUED FROM PAGE 3 OF FORM 2-C

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)	OUTFALL NUMBER
NM0022306	002

PART C - If you are a primary industry and this outfall contains process wastewater, refer to Table 2c-2 in the instructions to determine which of the GC/MS fractions you must test for. Mark "X" in column 2-a for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols. If you are not required to mark column 2-a (*secondary industries, nonprocess wastewater outfalls, and nonrequired GC/MS fractions*), mark "X" in column 2-b for each pollutant you know or have reason to believe is present. Mark "X" in column 2-c for each pollutant you believe is absent. If you mark column 2a for any pollutant, you must provide the results of at least one analysis for that pollutant. If you mark column 2b for any pollutant, you must provide the results of at least one analysis for that pollutant if you know or have reason to believe it will be discharged in concentrations of 10 ppb or greater. If you mark column 2b for acrolein, acrylonitrile, 2,4 dinitrophenol, or 2-methyl-4, 6 dinitrophenol, you must provide the results of at least one analysis for each of these pollutants which you know or have reason to believe that you discharge in concentrations of 100 ppb or greater. Otherwise, for pollutants for which you mark column 2b, you must either submit at least one analysis or briefly describe the reasons the pollutant is expected to be discharged. Note that there are 7 pages to this part; please review each carefully. Complete one table (*all 7 pages*) for each outfall. See instructions for additional details and requirements.

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
METALS, CYANIDE, AND TOTAL PHENOLS															
1M. Antimony, Total (7440-36-0)	X		X	<1		NA	NA	NA	NA	1	ug/l		NA	NA	NA
2M. Arsenic, Total (7440-38-2)	X			NA	NA	<5	<0.02	<5	<0.02	36	ug/l	lbs/d	NA	NA	NA
3M. Beryllium, Total (7440-41-7)	X		X	<0.5		NA	NA	NA	NA	1	ug/l		NA	NA	NA
4M. Cadmium, Total (7440-43-9)	X			NA	NA	<1	<4	<1	<4	36	mg/l	lbs/d	NA	NA	NA
5M. Chromium, Total (7440-47-3)	X		X	<1		NA	NA	NA	NA	1	ug/l		NA	NA	NA
6M. Copper, Total (7440-50-8)	X			NA	NA	<10	<0.04	<10	<0.04	36	ug/l	lbs/d	NA	NA	NA
7M. Lead, Total (7439-92-1)	X			NA	NA	<3	<0.01	1.60	0.006	36	ug/l	lbs/d	NA	NA	NA
8M. Mercury, Total (7439-97-6)	X			0.002		NA	NA	NA	NA	1	ug/l		NA	NA	NA
9M. Nickel, Total (7440-02-0)	X			1.24		NA	NA	NA	NA	1	ug/l		NA	NA	NA
10M. Selenium, Total (7782-49-2)	X			<1		NA	NA	NA	NA	1	ug/l		NA	NA	NA
11M. Silver, Total (7440-22-4)	X		X	<0.5		NA	NA	NA	NA	1	ug/l		NA	NA	NA
12M. Thallium, Total (7440-28-0)	X		X	<0.5		NA	NA	NA	NA	1	ug/l		NA	NA	NA
13M. Zinc, Total (7440-66-6)	X			NA	NA	<0.02	<0.08	<0.02	<0.08	12	mg/l	lbs/d	NA	NA	NA
14M. Cyanide, Total (57-12-5)	X			NA	NA	<0.01	<0.04	<0.01	<0.04	36	mg/l	lbs/d	NA	NA	NA
15M. Phenols, Total	X		X	<1.7		NA	NA	NA	NA	1	ug/l		NA	NA	NA
DIOXIN															
2,3,7,8-Tetra-chlorodibenzo-P-Dioxin (1764-01-6)			X	DESCRIBE RESULTS											

CONTINUE ON REVERSE

CONTINUED FROM THE FRONT

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X" a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION	(2) MASS	b. MAXIMUM 30 DAY VALUE (*if available*) (1) CONCENTRATION	(2) MASS	c. LONG TERM AVRG. VALUE (*if available*) (1) CONCENTRATION	(2) MASS	d. NO. OF ANALYSES	4. UNITS a. CONCEN-TRATION	b. MASS	5. INTAKE (*optional*) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION	(2) MASS	b. NO. OF ANALYSES
GC/MS FRACTION – VOLATILE COMPOUNDS															
1V. Accrolein (107-02-8)			X	<0.5						1	ug/l				
2V. Acrylonitrile (107-13-1)			X	<0.5						1	ug/l				
3V. Benzene (71-43-2)			X	<0.5						1	ug/l				
4V. Bis (*Chloro-methyl*) Ether (542-88-1)			X												
5V. Bromoform (75-25-2)			X	<0.5						1	ug/l				
6V. Carbon Tetrachloride (56-23-5)			X	<0.5						1	ug/l				
7V. Chlorobenzene (108-90-7)			X	<0.5						1	ug/l				
8V. Chlorodi-bromomethane (124-48-1)			X												
9V. Chloroethane (75-00-3)			X	<0.5						1	ug/l				
10V. 2-Chloro-ethylvinyl Ether (110-75-8)			X												
11V. Chloroform (67-66-3)			X	<0.5						1	ug/l				
12V. Dichloro-bromomethane (75-27-4)			X												
13V. Dichloro-difluoromethane (75-71-8)			X												
14V. 1,1-Dichloro-ethane (75-34-3)			X												
15V. 1,2-Dichloro-ethane (107-06-2)			X												
16V. 1,1-Dichloro-ethylene (75-35-4)			X												
17V. 1,2-Dichloro-propane (78-87-5)			X												
18V. 1,3-Dichloro-propylene (542-75-6)			X												
19V. Ethylbenzene (100-41-4)			X	<0.5						1	ug/l				
20V. Methyl Bromide (74-83-9)			X												
21V. Methyl Chloride (74-87-3)			X												

CONTINUE ON PAGE V-5

CONTINUED FROM PAGE V-4

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – VOLATILE COMPOUNDS (*continued*)															
22V. Methylene Chloride (75-09-2)			X	<2.5						1	ug/l				
23V. 1,1,2,2-Tetrachloroethane (79-34-5)			X	<0.5						1	ug/l				
24V. Tetrachloro-ethylene (127-18-4)			X												
25V. Toluene (108-88-3)			X	<0.5						1	ug/l				
26V. 1,2-Trans-Dichloroethylene (156-60-5)			X												
27V. 1,1,1-Trichloro-ethane (71-55-6)			X												
28V. 1,1,2-Trichloro-ethane (79-00-5)			X												
29V Trichloro-ethylene (79-01-6)			X												
30V. Trichloro-fluoromethane (75-69-4)			X	<0.5						1	ug/l				
31V. Vinyl Chloride (75-01-4)			X	<0.5						1	ug/l				
GC/MS FRACTION – ACID COMPOUNDS															
1A. 2-Chlorophenol (95-57-8)			X												
2A. 2,4-Dichloro-phenol (120-83-2)			X												
3A. 2,4-Dimethyl-phenol (105-67-9)			X												
4A. 4,6-Dinitro-O-Cresol (534-52-1)			X												
5A. 2,4-Dinitro-phenol (51-28-5)			X												
6A. 2-Nitrophenol (88-75-5)			X												
7A. 4-Nitrophenol (100-02-7)			X												
8A. P-Chloro-M-Cresol (59-50-7)			X												
9A. Pentachloro-phenol (87-86-5)			X												
10A. Phenol (108-95-2)			X												
11A. 2,4,6-Trichloro-phenol (88-05-2)			X												

CONTINUE ON REVERSE

CONTINUED FROM THE FRONT

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS															
1B. Acenaphthene (83-32-9)			X												
2B. Acenaphtylene (208-96-8)			X												
3B. Anthracene (120-12-7)			X												
4B. Benzidine (92-87-5)			X												
5B. Benzo (*a*) Anthracene (56-55-3)			X												
6B. Benzo (*a*) Pyrene (50-32-8)			X												
7B. 3,4-Benzo-fluoranthene (205-99-2)			X												
8B. Benzo (*ghi*) Perylene (191-24-2)			X												
9B. Benzo (*k*) Fluoranthene (207-08-9)			X												
10B. Bis (*2-Chloro-ethoxy*) Methane (111-91-1)			X												
11B. Bis (*2-Chloro-ethyl*) Ether (111-44-4)			X												
12B. Bis (*2-Chloroisopropyl*) Ether (102-80-1)			X												
13B. Bis (*2-Ethyl-hexyl*) Phthalate (117-81-7)			X												
14B. 4-Bromophenyl Phenyl Ether (101-55-3)			X												
15B. Butyl Benzyl Phthalate (85-68-7)			X												
16B. 2-Chloro-naphthalene (91-58-7)			X												
17B. 4-Chloro-phenyl Phenyl Ether (7005-72-3)			X												
18B. Chrysene (218-01-9)			X												
19B. Dibenzo (*a,h*) Anthracene (53-70-3)			X												
20B. 1,2-Dichloro-benzene (95-50-1)			X												
21B. 1,3-Di-chloro-benzene (541-73-1)			X												

CONTINUE ON PAGE V-7

CONTINUED FROM PAGE V-6

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS (*continued*)															
22B. 1,4-Dichloro-benzene (106-46-7)			X												
23B. 3,3-Dichloro-benzidine (91-94-1)			X												
24B. Diethyl Phthalate (84-66-2)			X												
25B. Dimethyl Phthalate (131 -11-3)			X												
26B. Di-N-Butyl Phthalate (84-74-2)			X												
27B. 2,4-Dinitro-toluene (121-14-2)			X												
28B. 2,6-Dinitro-toluene (606-20-2)			X												
29B. Di-N-Octyl Phthalate (117-84-0)			X												
30B. 1,2-Diphenyl-hydrazine (*as Azo-benzene*) (122-66-7)			X												
31B. Fluoranthene (206-44-0)			X												
32B. Fluorene (86-73-7)			X												
33B. Hexachloro-benzene (118-74-1)			X												
34B. Hexachloro-butadiene (87-68-3)			X												
35B. Hexachloro-cyclopentadiene (77-47-4)			X												
36B Hexachloro-ethane (67-72-1)			X												
37B. Indeno (*1,2,3-cd*) Pyrene (193-39-5)			X												
38B. Isophorone (78-59-1)			X												
39B. Naphthalene (91-20-3)			X												
40B. Nitrobenzene (98-95-3)			X												
41B. N-Nitro-sodimethylamine (62-75-9)			X												
42B. N-Nitrosodi-N-Propylamine (621-64-7)			X												

 CONTINUE ON REVERSE

CONTINUED FROM THE FRONT

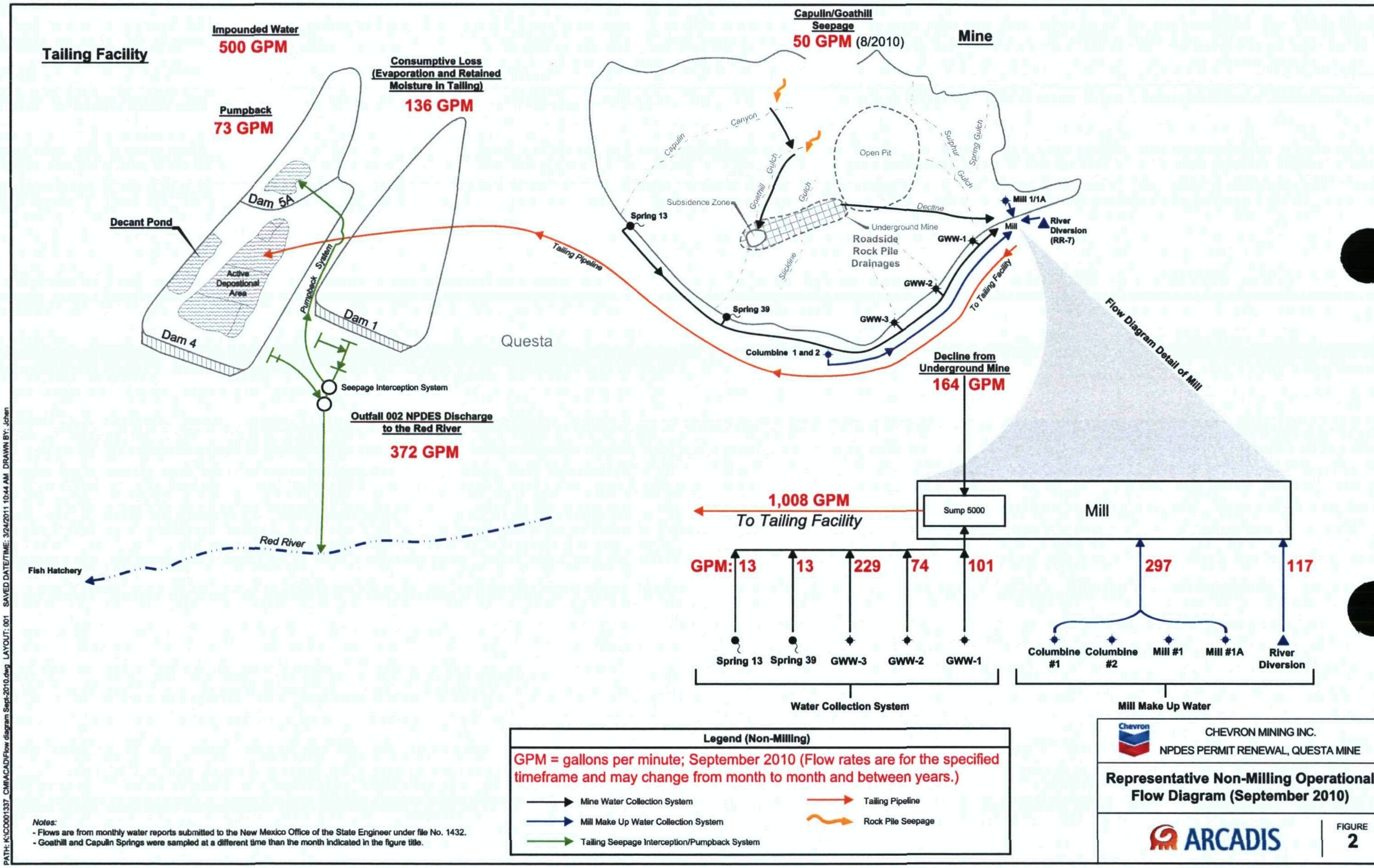
1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	a. TESTING REQUIRED	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCEN-TRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
				(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS (*continued*)															
43B. N-Nitro-sodiphenylamine (86-30-6)			X												
44B. Phenanthrene (85-01-8)			X												
45B. Pyrene (129-00-0)			X												
46B. 1,2,4-Tri-chlorobenzene (120-82-1)			X												
GC/MS FRACTION – PESTICIDES															
1P. Aldrin (309-00-2)			X												
2P. α-BHC (319-84-6)			X												
3P. β-BHC (319-85-7)			X												
4P. γ-BHC (58-89-9)			X												
5P. δ-BHC (319-86-8)			X												
6P. Chlordane (57-74-9)			X												
7P. 4,4'-DDT (50-29-3)			X												
8P. 4,4'-DDE (72-55-9)			X												
9P. 4,4'-DDD (72-54-8)			X												
10P. Dieldrin (60-57-1)			X												
11P. α-Enosulfan (115-29-7)			X												
12P. β-Endosulfan (115-29-7)			X												
13P. Endosulfan Sulfate (1031-07-8)			X												
14P. Endrin (72-20-8)			X												
15P. Endrin Aldehyde (7421-93-4)			X												
16P. Heptachlor (76-44-8)			X												

 CONTINUE ON PAGE V-9

EPA I.D. NUMBER (*copy from Item 1 of Form 1*)	OUTFALL NUMBER
NM0022306	002

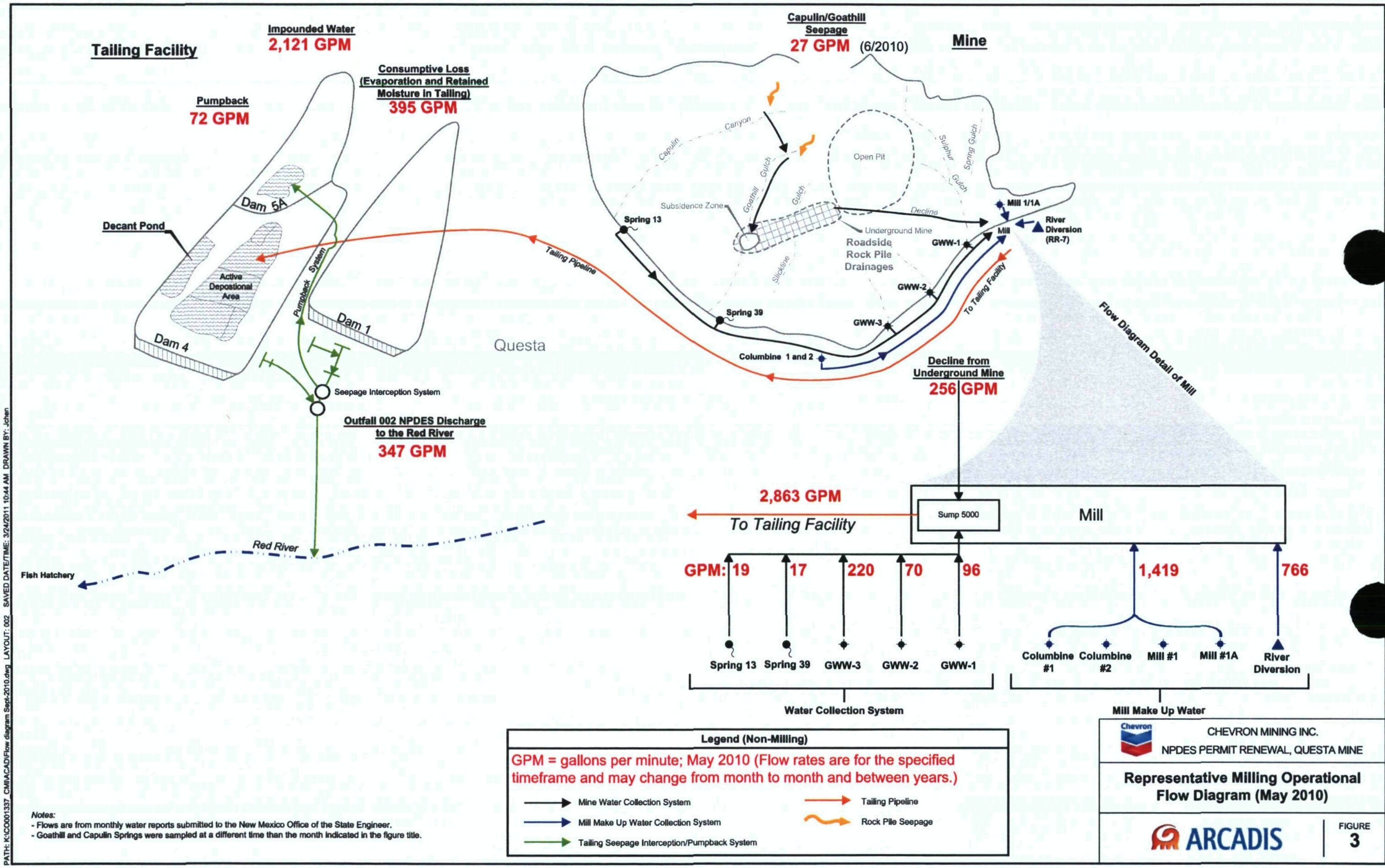
CONTINUED FROM PAGE V-8

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK "X" a. TESTING REQUIRED	2. MARK "X" b. BELIEVED PRESENT	2. MARK "X" c. BELIEVED ABSENT	3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION	3. EFFLUENT a. MAXIMUM DAILY VALUE (2) MASS	3. EFFLUENT b. MAXIMUM 30 DAY VALUE (*if available*) (1) CONCENTRATION	3. EFFLUENT b. MAXIMUM 30 DAY VALUE (*if available*) (2) MASS	3. EFFLUENT c. LONG TERM AVRG. VALUE (*if available*) (1) CONCENTRATION	3. EFFLUENT c. LONG TERM AVRG. VALUE (*if available*) (2) MASS	3. EFFLUENT d. NO. OF ANALYSES	4. UNITS a. CONCEN-TRATION	4. UNITS b. MASS	5. INTAKE (*optional*) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION	5. INTAKE (*optional*) a. LONG TERM AVERAGE VALUE (2) MASS	5. INTAKE (*optional*) b. NO. OF ANALYSES
GC/MS FRACTION – PESTICIDES (*continued*)															
17P. Heptachlor Epoxide (1024-57-3)			X												
18P. PCB-1242 (53469-21-9)			X												
19P. PCB-1254 (11097-69-1)			X												
20P. PCB-1221 (11104-28-2)			X												
21P. PCB-1232 (11141-16-5)			X												
22P. PCB-1248 (12672-29-6)			X												
23P. PCB-1260 (11096-82-5)			X												
24P. PCB-1016 (12674-11-2)			X												
25P. Toxaphene (8001-35-2)			X												



Representative Non-Milling Operational Flow Diagram (September 2010)

FIGURE 2


Tailing Facility
Impounded Water
2,121 GPM
Consumptive Loss
(Evaporation and Retained Moisture in Tailing)
395 GPM
Pumpback
72 GPM
Dam 5A
Decant Pond
Active Depositional Area
Pumpback System
Dam 1
Dam 4
Questa
Seepage Interception System
Outfall 002 NPDES Discharge to the Red River
347 GPM
Red River
Fish Hatchery
Tailing Pipeline
Capulin/Goathill Seepage
27 GPM
(6/2010)
Mine
Capulin
Canyon
Goathill
Gulch
Open Pit
Sulphur
Gulch
Spring Gulch
Subsidence Zone
Decline
Mill 1/1A
Mill
River Diversion (RR-7)
Spring 13
Underground Mine
Roadside Rock Pile Drainages
Slickline
GWW-1
GWW-2
GWW-3
Spring 39
To Tailing Facility
Columbine 1 and 2
Flow Diagram Detail of Mill
Decline from Underground Mine
256 GPM
2,863 GPM
To Tailing Facility
Sump 5000
Mill
GPM: 19
17
220
70
96
1,419
766
Spring 13
Spring 39
GWW-3
GWW-2
GWW-1
Columbine #1
Columbine #2
Mill #1
Mill #1A
River Diversion
Water Collection System
Mill Make Up Water
Legend (Non-Milling)
GPM = gallons per minute; May 2010 (Flow rates are for the specified timeframe and may change from month to month and between years.)
Mine Water Collection System
Mill Make Up Water Collection System
Tailing Seepage Interception/Pumpback System
Tailing Pipeline
Rock Pile Seepage
Notes:
- Flows are from monthly water reports submitted to the New Mexico Office of the State Engineer.
- Goathill and Capulin Springs were sampled at a different time than the month indicated in the figure title.
Chevron
CHEVRON MINING INC.
NPDES PERMIT RENEWAL, QUESTA MINE
Representative Milling Operational Flow Diagram (May 2010)
ARCADIS
FIGURE 3
PATH: K:\CO001337_CM\ACAD\Flow diagram Sept-2010.dwg LAYOUT: 002 SAVED DATE/TIME: 3/24/2011 10:44 AM DRAWN BY: Jchen

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Technical Memorandum

Supplemental Information and Water Quality Data Analysis for Chevron Mining Inc., NPDES Permit Renewal Application

This document is a summary of the data evaluations that were performed to support the renewal of NPDES permit #NM0022306 for the purpose of determining reasonable potential (RP) and appropriate effluent limitations for Outfall 002 at the Questa Mine, Chevron Mining Inc. The effluent data from Discharge Monitoring Reports (DMRs) from the past three years (1st quarter 2008 through 4th quarter 2010) were compiled and evaluated to determine if there was a technical basis for continuing to monitor all of the parameters in the previous permit.

Red River data from samples collected as part of the New Mexico ground water discharge permit, DP-1055, permit requirements were used to characterize the ambient stream conditions above the discharge. The samples were collected from site RR-16 between March 2008 and December 2010. These data, along with effluent DMR data, allowed the calculation of a projected worst case instream waste concentration (IWC) for each parameter which can then be compared to the most stringent New Mexico stream standard (December 2010). This comparison allows a determination of whether the discharge causes, has a reasonable potential to cause, or contributes to an instream excursion above the water quality standard.

1.0 Summary of current permit parameters

1.1 Technology Based Effluent Limits (TBELs)

The existing limits for pH, total suspended solids (TSS), fluoride, manganese and molybdenum are technology based effluent limits. As such, the effluent limits on these parameters are not based on water quality standards.

Data on current monitored parameters are listed below. All parameters are within or below current effluent limits, and show low variability.

- pH - monitored monthly
  - current limit 6.6 to 8.8
  - range from DMR data was 6.59 to 7.79 for 34 samples
  - median from DMR data was 7.26
- Total suspended solids (TSS) – monitored quarterly
  - Current limits - monthly average 20 mg/L, daily maximum 30 mg/L
  - all 11 measurements were non-detects

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- Fluoride – monitored quarterly
  - Concentration - current limit 3 mg/L
    - 3-yr range 0.5-1.3 mg/L for 11 samples – coefficient of variation (CV) is 19%
  - Mass - current limit 16.4 lbs/day
    - 3-yr mass range 2.56-5.39 lbs/day – CV is 19%

- Manganese – monitored monthly
  - Concentration - current limits - monthly average 1.0 mg/L, daily maximum 1.5 mg/L
    - 3-yr range 0.18-0.51 mg/L for 34 samples – CV is 16%
  - Mass - current limits - monthly 5.46 lbs/day, daily 8.2 lbs/day
    - 3-yr mass range 0.99-1.99 lbs/day – CV is 13%

- Molybdenum – monitored quarterly
  - Concentration - current limits – monthly average 3.3 mg/L, daily maximum 5.03 mg/L
    - 3-yr range 1.2-1.8 mg/L for 11 samples –CV is 13%
  - Mass - current limits - monthly 9.6 lbs/day, daily 14.7 lbs/day
    - 3-yr mass range 4.47-6.22 lbs/day – CV is 9%

- Zinc - monitored quarterly
  - Concentration - current limits - 0.2 mg/L, 0.58 lbs/day
    - All 11 measurements were non-detects (<0.02 mg/L)

1.2 Water Quality Based Effluent Limits (WQBELs)

Water quality based effluent limits (WQBEL) were determined for those parameters that had a reasonable potential to exceed water quality criteria during the last permit renewal. A summary of the data reported on DMR forms from January 2008 to December 2010 are listed below. The majority of the measured parameters were non-detects for the past 3-5 years.

- Arsenic – monthly
  - Concentration - current limits - monthly 0.22 mg/L, daily 0.33 mg/L
  - Mass - current limits - monthly 1.2 lbs/day, daily 1.8 lbs/day
  - all 34 measurements were non-detects (<0.005 mg/L)

- Cadmium- monthly
  - Concentration - current limits - monthly 0.0016 mg/L, daily 0.0024 mg/L
  - Mass - current limits - monthly 0.009 lbs/day, daily 0.013 lbs/day
  - all 34 measurements were non-detects (<0.001 mg/L)

- Copper- monthly
  - Concentration - current limits - monthly 0.032 mg/L, daily 0.049 mg/L

- Mass - current limits - monthly 0.12 lbs/day, daily 0.18 lbs/day
- all 34 measurements were non-detects (<0.01 mg/L)

- Lead- monthly
  - Concentration - current limits - monthly 0.1 mg/L, daily 0.15 mg/L
  - Mass - current limits - monthly 0.55 lbs/day, daily 0.82 lbs/day
  - one measured value, 0.0052 mg/L, May 2009
  - all of the other 33 measurements were non-detects (<0.003 mg/L)

- Mercury- monthly
  - Concentration - current limits - monthly 0.00011 mg/L, daily 0.00017 mg/L
  - Mass - current limits - monthly 0.0006 lbs/day, daily 0.00093 lbs/day
  - all 34 measurements were non-detects (<0.0002 mg/L)
  - Because the MDL for the reported DMR sample data was above the current MQL of 0.005 μg/L, an additional sample was analyzed in March 2011 and had a measured value of 0.002 μg/L, indicating that previous non-detect values were likely below the current MQL as well

- Aluminum- monthly
  - Concentration - current limits - monthly 0.058 mg/L, daily 0.087 mg/L
  - Mass - current limits - monthly 0.169 lbs/day, daily 0.254 lbs/day
  - One measured value, 0.25 mg/L, 0.802 lbs/day, June 2009
    - This event is an anomaly and is explained in the 5-day Report issued by Chevron Mining, July 2009 (attached)
  - All of the other 33 measurements were non-detects (<0.05 mg/L)

- Cyanide- monthly
  - Concentration - current limits - monthly 0.0147 mg/L, daily 0.022 mg/L
  - Mass - current limits - monthly 0.0429 lbs/day, daily 0.064 lbs/day
  - All 34 measurements were non-detects (<0.01 mg/L)

2.0 Reasonable Potential (RP) Calculations

Reasonable potential calculations were performed on all parameters with WQBELs in the current permit, and those parameters which are "believed present" in the effluent, and for which NM water quality criteria are currently available. When the previous permit was issued, there were no aquatic life water quality standards for manganese or molybdenum. However, as a result of the recent changes in New Mexico water quality standards, there are now water quality criteria for both molybdenum and manganese, which would allow calculation of water quality-based effluent limitation (WQBELs) that are potentially more stringent than the TBELs. Therefore, these parameters were evaluated using the RP procedure to determine if there is a potential to exceed or contribute to an exceedence of current water quality criteria.

RP was calculated following *Procedures for Implementing National Pollutant Discharge Elimination System Permits in New Mexico* (USEPA 2009). According to this guidance samples reported as less than the detection limit were handled in the following manner:

- If the value was below the method detection limit (MDL), and the MDL is less than the current minimum quantification level (MQL), a "0" was used for analyzing RP
  - This applied to cyanide, cadmium, and zinc
- If all values were below the MDL, and the MDL is greater than the current MQL, the value of the MDL was used
  - This applied to arsenic and copper
- If at least one value was above the MDL, and the other values were below the MDL, all data reported as <MDL were counted as ½ MDL instead
  - This applied to lead and aluminum

This procedure first calculates reasonable potential for toxics by estimating the 95th percentile concentration (Ce) of an effluent constituent by multiplying the average pollutant concentration in the effluent (Cp) by 2.13, which is also considered the acute Instream Waste Concentration, resulting in the Acute Cd (Table 1). Acute aquatic life criteria are from the most recent update to NM water quality standards (NMWQCC 2010). Pollutants in Table 1 for which new criteria were derived or substantially changed during the last Triennial Review of Water Quality Standards are presented both as their previous criteria (2007) and as the "2010" criteria. Comparisons to the 2010 criteria are most up to date and appropriate, but both comparisons are presented for completeness. As all water quality data were measured as "total" concentrations, and criteria are given as "dissolved" concentrations, the aquatic criteria listed in Table 1 have been converted to "total" concentrations for direct comparison to water quality parameters. Conversions were done by using the partition coefficients for each metal (USEPA 2010), and a total suspended solids concentration of 10 mg/L, which is the estimated TSS in the Red River as used in the previous permit renewal calculations. The hardness value used for calculation of hardness based aquatic life criteria was 158 mg/L, based on current data from the Red River upstream of Outfall 002. For mercury, samples collected under the old permit requirements and reported on DMR's did not meet the current MQL requirement; therefore, additional samples were collected prior to submittal of this application and were used in RP analysis.

Based on the analysis of 95th percentile concentrations, there is no potential for exceedance of any of the acute aquatic life criteria (Table 1).

Table 1: Effluent concentrations (Cp) and calculated 95th percentile concentrations (Cd) for comparison to acute water quality criteria. The * indicates parameters which have hardness based criteria.

Pollutant (total)	Cp (µg/L)	Acute Cd (µg/L)	Acute Aquatic Life Criteria -as total (µg/L)
Aluminum*	27	57.5	750
Aluminum*(2010)	27	57.5	6400
Arsenic	5	10.7	644
Cadmium*	0	0	2.5
Cadmium* (2010)	0	0	2.4
Chromium*	0	0	4100
Copper*	10	21.3	59.8
Cyanide	0	0	22.0
Lead*	1.60	3.2	576
Manganese* (2010)	400	852	3477
Mercury	0.002	0.004	2.4
Molybdenum (2010)	1480	3152	7920
Nickel*	1.24	2.64	1599
Selenium	0	0	20
Silver*	0	0	22.8
Zinc	0	0	501
Zinc (2010)	0	0	695
Total Residual Chlorine	0	0	19

In addition, the chronic and human health Instream Waste Concentrations (Chronic Cd) were calculated using the following formula:

$$Cd=[(F*Qa*Ca) + (Qe*Cp*2.13))] / (F*Qa + Qe)$$

Where Cd = Instream Waste Concentration
F = Fraction of stream allowed for mixing (=1)
Cp = Average plant effluent concentration
Ca = Ambient stream concentration upstream of discharge
Qe = Plant effluent flow (=0.645 MGD or 0.998 cfs)
Qa = Critical low flow - 4Q3, (=4.85 MGD or 7.5 cfs)
Qh = Harmonic mean flow for human health criteria (=12.1 MGD or 18.7 cfs)

As with the acute data, all water quality data were measured as "total" concentrations, and criteria are given as "dissolved" concentrations. Thus, the aquatic life criteria listed in Table 2 have been converted to "total" concentrations for direct comparison to water quality parameters using the partition coefficients for each metal (USEPA 2009), and a total suspended solids concentration of 10 mg/L, which is the estimated TSS in the Red River. Chronic aquatic life criteria are from the most recent update to NM water quality standards (NMWQQ 2010). Pollutants in Table 2 for which new criteria were derived or substantially changed during the last Triennial Review of Water Quality Standards are presented both as their previous criteria (2007) and as the "2010" criteria. Comparisons to the 2010 criteria are most up to date and appropriate, but both comparisons are presented for completeness. The chronic instream waste concentrations were compared to chronic aquatic life criteria and other designated use criteria. The designated uses for the Red River are currently listed as Irrigation, Livestock Watering, and Wildlife Habitat.

Based on the analyses of chronic instream waste concentrations, there is potential for exceedance of the chronic aquatic life criterion for aluminum, but only if the old, out-of-date criterion is used. This potential exceedance is due to the background concentration of aluminum in the Red River from natural sources upstream of the mine (NMED 2006), since the effluent actually dilutes those instream concentrations.

Table 2: Ambient concentrations (Ca), effluent concentrations (Cp) and calculated instream waste concentrations (Cd) for comparison to chronic water quality criteria and designated uses for the Red River. All water quality criteria have been converted to total concentration where appropriate for comparison to measured values. The * indicates parameters which have hardness based criteria.

Pollutant	Ca (µg/L)	Cp (µg/L)	Chronic Cd (µg/L)	Chronic Aquatic Life Criteria (µg/L)	Irrigation Limits (µg/L)	Livestock/ Wildlife Limits (µg/L)
Aluminum*	2400	27	2125	87	5000	n/a
Aluminum* (2010)	2400	27	2125	2564	5000	n/a
Arsenic	0	5	1.3	284	189	379
Boron	0	31	7.8	n/a	750	5000
Cadmium*	0	0	0	0.3	10	50
Cadmium* (2010)	0	0	0	0.6	10	50
Chromium*	0.78	0	0.69	533	495	4948
Cobalt	3.4	1.05	3.3	n/a	50	1000
Copper*	22	10	21.9	38.3	578	1446
Cyanide	No data	0	0	5.2	n/a	5.2
Gross Alpha	No data	30.1	7.5	n/a	n/a	15
Lead*	1.46	1.60	1.7	22.4	27,189	544
Manganese* (2010)	260	400	329	1921	n/a	n/a
Mercury	0	0.002	0.001	0.012	n/a	0.77
Molybdenum (2010)	5.5	1480	375	1895	1000	n/a
Nickel*	14	1.24	12.7	177.6	n/a	n/a
Nitrate+Nitrite	0	0	0	n/a	n/a	132 mg/L
Selenium	1.1	0	1.0	5.0	*	5.0
Total Residual Chlorine	0	0	0	11	n/a	n/a
Vanadium	1.8	1.38	1.9	n/a	100	100

Pollutant	Ca (µg/L)	Cp (µg/L)	Chronic Cd (µg/L)	Chronic Aquatic Life Criteria (µg/L)	Irrigation Limits (µg/L)	Livestock/ Wildlife Limits (µg/L)
Zinc*	120	0	106	501	6988	87,351
Zinc* (2010)	120	0	106	642	6988	87,351

All of the calculated instream waste concentrations for parameters with Human Health criteria are well below the limits (Table 3).

Table 3: Ambient concentrations (Ca), effluent concentrations (Cp) and calculated instream waste concentrations (Cd) for comparison to human health water quality criteria.

Pollutant	Ca (µg/L)	Cp (µg/L)	Human Health Cd (µg/L)	Human Health Limits (µg/L)
Cyanide	No data	0	0	140
Nickel	14	1.24	13.4	4600
Selenium	1.1	0	1.04	4200
Thallium	0	0	0	0.47
Zinc	120	0	114	26,000

3.0 Supplemental Information

Per requirements in *Procedures for Implementing National Pollutant Discharge Elimination System Permits in New Mexico* (USEPA 2009), we are providing results of the analyses of pollutants with potential for human health risks. The majority of the parameters were non-detects, and of the parameters with measured concentrations all except selenium were below the practical quantitation limit (PQL). Dissolved selenium was 3.1 µg/L, which is well below the human health criteria of 4,200 µg/L. All method detection limits (MDL's) meet current state of New Mexico MQL's. Therefore, there is no reasonable potential for exceedance of human health criteria for any of these pollutants.

Table 4: Pollutants analyzed for potential to exceed human health criteria. ND = not detected at or above the PQL

Pollutant	Concentration (µg/L)	MDL (µg/L)	PQL (µg/L)
1,1,2,2-Tetrachloroethane	ND	N/A	0.5
1,1,2-Trichloroethane	ND	N/A	0.5
1,1-Dichloroethylene	ND	N/A	0.5
1,2,4-Trichlorobenzene	ND	N/A	0.5
1,2-Dichlorobenzene	ND	N/A	0.5
1,2-Dichloroethane	ND	N/A	0.5
1,2-Dichloropropane	ND	N/A	0.5
1,2-Diphenylhydrazine	ND	N/A	0.5
1,2--trans-Dichloroethylene	ND	N/A	0.5
1,3-Dichlorobenzene	ND	N/A	0.5
1,3-Dichloropropene	ND	N/A	0.5
1,4-Dichlorobenzene	ND	N/A	0.5

Pollutant	Concentration (µg/L)	MDL (µg/L)	PQL (µg/L)
2,3,7,8-TCDD (Dioxin)	ND	N/A	0.519 pg/L
2,4,6-Trichlorophenol	ND	N/A	0.5
2,4-Dichlorophenol	ND	N/A	0.5
2,4-Dimethylphenol	ND	N/A	0.5
2,4-Dinitrophenol	ND	N/A	0.5
2,4-Dinitrotoluene	ND	N/A	0.5
2-Chloronapthalene	ND	N/A	0.5
2-Chlorophenol	ND	N/A	0.5
2-Methyl-4, 6-Dinitrophenol	ND	N/A	0.5
3,3-Dichlorobenzidine	ND	N/A	0.5
4, 4'-DDT and derivatives	ND	N/A	0.1
Acenaphthene	ND	N/A	0.5
Acrolein	ND	N/A	2.2
Acrylonitrile	ND	N/A	0.5
Aldrin	ND	N/A	0.01
Alpha-BHC	ND	N/A	0.01
Alpha-Endosulfan	ND	N/A	0.01
Anthracene,	ND	N/A	0.5
Antimony (D)	0.31	0.03	1.0
Arsenic (D)	0.24	0.03	1.0
Benzene	ND	N/A	0.5
Benzidine,	ND	N/A	0.5
Benzo(a)anthracene	ND	N/A	0.5
Benzo(a)pyrene	ND	N/A	0.5
Benzo(b)fluoranthene	ND	N/A	0.5
Benzo(k)fluoranthene	ND	N/A	0.5
Beta-BHC	ND	N/A	0.01
Beta-Endosulfan	ND	N/A	0.01
Bis (2-chloroethyl) Ether	ND	N/A	0.5
Bis (2-chloroisopropyl) Ether	ND	N/A	0.5
Bis (2-ethylhexyl) Phthalate	ND	N/A	0.5
Bromoform	ND	N/A	0.5
Butyl Benzyl Phthalate	ND	N/A	0.5
Carbon Tetrachloride	ND	N/A	0.5
Chlordane	ND	N/A	0.1
Chlorobenzene	ND	N/A	0.5
Chloroform	ND	N/A	0.5
Chrysene	ND	N/A	0.5
Clorodibromomethane	ND	N/A	0.5
Cyanide, weak acid dissociable	ND	N/A	0.1 (mg/L)
Dibenzo(a,h)anthracene	ND	N/A	0.5
Dibutyl Phthalate	ND	N/A	0.5
Dichlorobromomethane	ND	N/A	0.5
Dieldrin	ND	N/A	0.01
Diethyl Phthalate	ND	N/A	0.5
Dimethyl Phthalate	ND	N/A	0.5
Endosulfan sulfate	ND	N/A	1.01
Endrin	ND	N/A	0.01
Endrin Aldehyde	ND	N/A	0.01
Ethylbenzene	ND	N/A	0.5
Fluoranthene	ND	N/A	0.5
Fluorene	ND	N/A	0.5
Gamma-BHC	ND	N/A	0.01
Heptachlor 90	ND	N/A	0.01
Heptachlor Epoxide	ND	N/A	0.01
Hexachlorobenzene	ND	N/A	0.5
Hexachlorobutadiene	ND	N/A	0.5

Pollutant	Concentration (µg/L)	MDL (µg/L)	PQL (µg/L)
Hexachlorocyclopentadiene	ND	N/A	0.5
Hexachloroethane	ND	N/A	0.5
Indeno (1,2,3-cd)Pyrene	ND	N/A	0.5
Isophorone	ND	N/A	0.5
Methyl Bromide	ND	N/A	0.5
Methylene Chloride	ND	N/A	2.5
Nickel (D)	ND	1.0	10
Nitrobenzene	ND	N/A	0.5
n-Nitrodimethylamine	ND	N/A	0.5
n-Nitrosodi-n-Propylamine	ND	N/A	0.5
n-Nitrosodiphenylamine	ND	N/A	0.5
PCBs	ND	N/A	0.2
Pentachlorophenol	ND	N/A	0.5
Phenol	ND	N/A	0.5
Pyrene	ND	N/A	0.5
Selenium (D)	3.1	0.082	1.0
Tetrachloroethylene	ND	N/A	0.5
Thallium (D)	0.01	0.0021	1.0
Toluene	ND	N/A	0.5
Toxaphene	ND	N/A	0.1
Trichloroethylene	ND	N/A	0.5
Vinyl Chloride	ND	N/A	0.5
Zinc (D)	8.9	4.1	10.0

4.0 Additional Data and RP for Outfall 002 combined with Pumpback System Water

As described in the Evaluation of Best Management Practices and Storm Water Management document (ARCADIS 2011) included in this renewal packet, a pumpback system was installed at the tailing facility in 2003 to reduce the metal loads at Outfall 002. According to the Record of Decision (ROD) issued by EPA in December 2010 to the Questa Mine, one alternative for the tailing facility is cessation of the pumpback system. If the pumpback system were no longer in use, this additional volume of water and its constituents would be combined with the 002 outfall and discharged to the Red River. Therefore, in addition to the evaluation of the discharge from Outfall 002, we have also included data and a RP analysis for the potential combined discharge that would exist if the pumback system were turned off.

This NPDES permit application includes a request that two options for discharge limits be written into the permit to provide CMI with flexibility in its operations. The first set of permit limits would be for discharge of Outfall 002 only, (i.e., with the pumpback system still operating), and the second set of limits would be for Outfall 002 combined with pumpback water. (i.e., with the pumpback system turned off). This would be similar to the manner in which the permit was written in the past, when limits for 002 were provided separately from the combined limits for Outfall 002 and 001.

Reasonable potential for the combined outfall was performed in the same manner as for Outfall 002 alone. DMR data from Outfall 002 were combined with flow-weighted data from two samples collected from the pumback system.

The results of the RP analysis were similar to those found when analyzing Outfall 002 under current conditions with the pumpback system operating. Based on the calculations of the 95th percentile concentrations there is no potential for Outfall 002 plus the pumpback water to exceed acute aquatic life criteria (Table 5).

Table 5: Effluent concentrations (Cp) using combined 002 and pumpback system data and calculated 95th percentile concentrations (Cd) for comparison to acute water quality criteria. The * indicates parameters which have hardness based criteria.

Pollutant (total)	Cp (µg/L)	Acute Cd (µg/L)	Acute Aquatic Life Criteria -as total (µg/L)
Aluminum*	56.5	120	750
Aluminum*(2010)	56.5	120	6400
Arsenic	1.0	2.1	644
Cadmium*	0.3	0.64	2.5
Cadmium* (2010)	0.3	0.64	2.4
Chromium*	2.1	4.5	4100
Copper*	1.7	3.6	59.8
Cyanide	No data	No data	22.0
Lead*	0.1	0.21	576
Manganese* (2010)	370	788	3477
Mercury	0.02	0.04	2.4
Molybdenum (2010)	1720	3664	7920
Nickel*	4.0	8.5	1599
Selenium	3.0	6.4	20
Silver*	0.3	0.64	22.8
Zinc	2	4.3	501
Zinc (2010)	2	4.3	695
Total Residual Chlorine	No data	No data	19

Results for chronic RP analysis of Outfall 002 plus pumpback water were also similar to those calculated for Outfall 002 alone (Table 6). Again, there is potential for exceedance of the chronic aquatic life criterion for aluminum, but only if the outdated criterion (2007) is used. As before, this potential exceedance is due to the background concentration concentrations of aluminum in the Red River, since the combined flows have even lower aluminum concentrations than 002 alone.

Table 6: Ambient concentrations (Ca), effluent concentrations (Cp) and calculated instream waste concentrations (Cd) for comparison to chronic water quality criteria and designated uses for the Red River. All water quality criteria have been converted to total concentration where appropriate for comparison to measured values. The * indicates parameters which have hardness based criteria.

Pollutant	Ca (µg/L)	Cp (µg/L)	Chronic Cd (µg/L)	Chronic Aquatic Life Criteria (µg/L)	Irrigation Limits (µg/L)	Livestock/ Wildlife Limits (µg/L)
Aluminum*	2400	56.5	2089	87	5000	n/a
Aluminum* (2010)	2400	56.5	2089	2564	5000	n/a
Arsenic	0	1.0	0.29	284	189	379
Boron	0	87	25.3	n/a	750	5000
Cadmium*	0	0.3	0.09	0.3	10	50
Cadmium* (2010)	0	0.3	0.09	0.6	10	50
Chromium*	0.78	2.1	1.28	533	495	4948
Cobalt	3.4	1.2	3.3	n/a	50	1000
Copper*	22	1.7	19.5	38.3	578	1446
Cyanide	No data	No data	No data	5.2	n/a	5.2
Gross Alpha	No data	No data	No data	n/a	n/a	15
Lead*	1.46	0.1	1.29	22.4	27,189	544
Manganese* (2010)	260	370	332	1921	n/a	n/a
Mercury	0	0.02	0.006	0.012	n/a	0.77
Molybdenum (2010)	5.5	1720	504	1895	1000	n/a
Nickel*	14	4	13.3	177.6	n/a	n/a
Nitrate+Nitrite	0	0	0	n/a	n/a	132 mg/L
Selenium	1.1	3	1.82	5.0	*	5.0
Total Residual Chlorine	No data	No data	No data	11	n/a	n/a
Vanadium	1.8	0.6	1.7	n/a	100	100
Zinc*	120	2.0	104	501	6988	87,351
Zinc* (2010)	120	2.0	104	642	6988	87,351

5.0 Conclusions

With the last permit renewal, the monitoring frequency for all technology based parameters, with the exception of manganese, was reduced from monthly to quarterly. The manganese concentrations measured in the past three years are all substantially below the current limits and show little variability. Additionally, the measured manganese concentrations are approximately four times lower than the 2010 acute water quality criteria for manganese, indicating that there is little potential for manganese criteria to be exceeded. Furthermore, manganese is not included as one of the limited parameters in the effluent guidelines for this industry promulgated in 1982 (40 CFR, Part 440, Subpart J – Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory), and the previous fact sheet for the permit does not clarify where the manganese limit originated. Therefore it would seem appropriate to remove the manganese monitoring requirement from the permit.

Results of the RP analysis for Outfall 002 demonstrate that there is no reasonable potential for any of the parameters with WQBELs to exceed acute aquatic life criteria. These RP evaluations also indicate that there is no reasonable potential for any of the parameters with WQBELs to exceed chronic aquatic life criteria with the possible exception of aluminum. The aluminum chronic criterion would only be exceeded using the old, out-of-date criterion, with no reasonable potential to exceed the updated chronic criterion. Again, the only reason for the "potential" aluminum exceedances is due to the background concentrations of aluminum in the Red River. All other parameters are substantially below the chronic aquatic life criteria, as well as the other designated use criteria, and so are not likely to exceed any of these criteria. There is also no potential for exceedance of any of the parameters with human health limits.

Ultimately, because none of the metals criteria demonstrate the reasonable potential to exceed WQBELs, we recommend eliminating discharge limits for these parameters and changing them to "report only" monitoring requirements.

Results of the RP analysis for Outfall 002 plus the pumpback water were similar to the results of Outfall 002 alone with the pumpback system still operating; therefore, our recommendations for discharge limits and monitoring requirements would be the same for this alternative.

6.0 References

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Evaluation of Best Management Practices and Storm Water Management (Updated)

Questa Mine and Tailing Facility, Questa, New Mexico

Project No. CO001337.0003

March 18, 2011

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Evaluation of Best Management Practices and Storm Water Management (Updated)

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March 18, 2011

Executive Summary

Chevron Mining Inc. (CMI) has implemented Best Management Practices (BMPs) at the Questa Mine, which are designed to prevent or reduce discharge of mine-impacted groundwater and surface flow to the Red River, under a National Pollutant Discharge Elimination System (NPDES) Permit No. NM0022306. Reduction of mine water discharge has been accomplished through implementation of BMPs that reduce loading to the alluvial aquifer and limit the hydraulic connection with the river. CMI has also implemented storm water controls and water management at the mine through a Storm Water Pollution Prevention Plan (SWPPP). Storm water controls and a seepage collection system are also in place at the tailing facility. An assessment of these control systems is performed that includes a description of the control systems, followed by an evaluation in terms of their ability to reduce impacts to the river's water quality from mine and tailing waters. The information is presented for CMI's NPDES renewal process.

The evaluations found that the water quality of the Red River has improved along the mine site and tailing facility in recent years, indicating that CMI's BMPs, storm water controls, and water management systems are working to prevent impacts to the river. There are no point or non-point discharges from the mine site and tailing facility that have resulted in an exceedance of 2010 numeric surface water criteria, as defined in 20.6.4.900 of the New Mexico Administrative Code (NMAC), which are anticipated to be approved by EPA.

At the mine site, BMPs in place include groundwater extraction wells at the base of the roadside rock piles and two seepage interception systems along the northern river bank. Analyses in the Remedial Investigation/Feasibility Study (RI/FS) found that these BMPs remove constituent loads equivalent to and greater than those produced by the roadside rock piles. These loading analyses were used by the U.S. Environmental Protection Agency (EPA) as supporting documentation in the previous NPDES renewal. The storm water controls at the mine prevent runoff from discharging to the river, which is documented by observations made during the RI and continued observations by CMI personnel.

Combined, the BMPs and storm water controls at the mine site have resulted in an improvement in the river's water quality over the last two decades. Decreasing trends in constituent concentrations have been observed in the river at the downstream boundary of the mine to a point that the 2010 New Mexico chronic aquatic life criterion for aluminum has not been exceeded since 2008. This improvement in water quality is

remarkable considering that drainages upstream of the mine contain hydrothermal alteration scars, which generate natural sources of acidic metal-laden runoff and sediment loading of the river. The hydraulic connection between the mine and the river that remains does not result in exceedance of any New Mexico surface water quality criteria. In December 2010, the EPA issued the Record of Decision (ROD) for the Questa Mine that includes additional groundwater extraction near the mouths of each site drainage, which will further reduce any hydraulic connection.

The tailing facility has been operated for more than 40 years where tailing has been discharged into two impoundments. Currently, tailing is primarily discharged to the Dam No. 4 impoundment and to a lesser degree into the Dam No. 5A impoundment. A small area of impounded process water has been maintained behind Dam No. 1 for suppression of dust since 1986. However, CMI no longer discharges process water to this area of the impoundment and it is dry as of the close of 2010. A seepage interception system is operated south of the Dam No. 1 impoundment and the eastern flank of the Dam No. 4 impoundment, which includes seepage barriers and extraction wells that collect tailing seepage from the impoundments.

Evaluations performed under groundwater Discharge Permit 933, found that the seepage interception system collects most of the seepage from the Dam No. 1 impoundment before reaching the southern property boundary. There has been evidence of pipeline leakage and this leakage was addressed in 2010 by lining the Outfall 002 discharge pipeline and replacing other system pipelines. Most of the seepage that is not collected occurs at the Dam No. 4 impoundment. The quality of the Red River downgradient of the tailing facility generally improves, evidenced by decreasing concentrations of constituents such as aluminum and manganese. Molybdenum is one of the few constituents that increase in the river, but this is solely due to permitted discharges from Outfall 002 and not from groundwater discharging to the river. There are no constituents in this reach of the river that exceed 2010 New Mexico acute or chronic aquatic life criteria based on data collected during the RI in 2002 and 2003 and recent sampling data of the river in March 2011. EPA's selected remedy in the ROD includes enhancements to the seepage interception system, which will further reduce the potential for hydraulic connection between the impoundments and the river. To the extent that there may be a hydraulic connection, the ROD explicitly states that the choice of remedial alternatives and remedial action objectives was to prevent or mitigate that connection to ensure surface water quality (see ROD at pp. 2-447, 2-455, 2-656, 2-695).

Figures

1. Introduction

The U.S. Environmental Protection Agency (EPA) issued a National Pollutant Discharge Elimination System (NPDES) Permit No. NM0022306 on December 8, 2000 that required Molycorp (now Chevron Mining Inc. [CMI]) to implement best management practices (BMPs) at the Questa mine site. The BMPs are designed to reduce discharge of mine water to the Red River by reducing loading to the alluvial aquifer and thus the hydraulic connection with the river. CMI has also implemented storm water controls and water management at the mine through a Storm Water Pollution Prevention Plan (SWPPP), which describes the inspection, implementation, and maintenance of control measures and BMPs, and sets forth corrective actions where required (Souder, Miller & Associates 2009). Under the SWPPP, the mine site is divided into 21 main storm water and snowmelt inspection units. Storm water controls have also been implemented at the tailing facility as well as a seepage interception system to collect tailing seepage and reduce the seepage migration within the alluvial aquifer.

The purpose of this document is to describe and evaluate the BMPs and storm water control systems at the mine and tailing facility, and to provide information for CMI's NPDES permit renewal process. These control systems are evaluated for:

- their ability to prevent or reduce mine and tailing waters from reaching the Red River, and
- potential impacts these waters may have on the water quality of the river.

Most of the information used in the evaluations is from the Remedial Investigation (RI) Report (URS 2009a) and Feasibility Study (FS) Report (URS 2009b), supplemented with information from the annual monitoring report (ARCADIS 2010) for the seepage interception system at the tailing facility, which is a requirement of the groundwater Discharge Permit (DP) 933. Recent water quality data for the Red River south of the tailing facility was collected by CMI in March 2011 to provide additional information for the NPDES permit renewal. Information from other investigations is referenced as appropriate. Some information relative to the hydrology and hydraulic connection between the mine and tailing facility and river was provided to EPA in a November 15, 2010 letter (CMI 2010a), which was requested by EPA during its NPDES inspection of the site on October 26 and 27, 2010. Water quality data relied upon in the evaluations is from the CMI MS Access™ database.

The evaluation for the mine site is presented in Section 2. The tailing facility is evaluated in Section 3.

2. Mine Site

An evaluation of the BMPs and storm water controls at the mine site is presented in this section. Descriptions of BMPs, hydrology and storm water controls for each mine drainage, and factors that influence the hydraulic connection of the mine with the Red River are presented first, followed by the evaluation.

2.1 BMPs

CMI operates groundwater collection systems at locations along the southern boundary of the mine site adjacent to the Red River. The systems were installed in fall 2002 as part of BMPs under the NPDES permit began operation in February 2003. The systems include groundwater withdrawal wells along the base of the roadside rock piles (Sulphur Gulch South, Middle, and Sugar Shack South) and spring collection systems along the north bank of the Red River at Springs 39 and 13 (**Figure 1**). Groundwater from the withdrawal wells and water from the spring collection systems is pumped to the mill, treated using lime neutralization or pH adjustment, and is used as makeup water for pipeline maintenance and to transport slurry.

The withdrawal wells (GWW-1, -2, and -3) were installed along the base of the roadside rock piles to collect water either infiltrating through the rock piles or naturally flowing through the hydrothermally altered colluvium in drainages underlying the rock piles on the north side of the river. The average combined pumping of the wells was approximately 410 gallons per minute (gpm) in 2010, which is about nine times greater than the estimated flux (infiltration) of water through the roadside rock piles under average precipitation conditions.

Two spring collection systems are operated at the mine site. One is located at Spring 39, which is at the western end of Columbine Park, and the other is at Spring 13 near the mouth of Capulin Canyon. In 2010, the combined flow from the two systems averaged 30 gpm. The two collection systems remove potential mine-related and naturally occurring metal loads from the shallow alluvial aquifer. This water would otherwise enter the Red River because groundwater discharge to the river is observed in the areas of the two systems. The water quality at the Spring 39 system has improved dramatically in recent years. As an example, the aluminum concentration was as high as 30 milligrams per liter (mg/L) when the system began operation and has decreased to near or below the New Mexico numeric groundwater standard of 5 mg/L. This improvement is primarily due to removal of constituent mass by the upgradient BMP groundwater withdrawal well system. The quality of water collected by the Spring 13 system has not improved; however, the RI Report and EPA have concluded that the source of the poor groundwater quality at this spring is likely to be unrelated to mining activities.

2.2 Hydrology and Storm Water Management

The mine site is comprised of three primary drainages: Sulphur Gulch, Goathill Gulch, and Capulin Canyon. Surface water flow is generally present in these drainages only after large precipitation events. Surface water runoff from the disturbed areas on the mine site is managed through storm water diversion and catchments in such a manner as to prevent discharges to the Red River. The storm water management systems are illustrated on **Figure 1**.

2.2.1 Sulphur Gulch

Sulphur Gulch drains the eastern portion of the mine site and is generally southeast facing. The upper portion of the Sulphur Gulch watershed contains a large hydrothermal scar, covering approximately 10 percent of the Sulphur Gulch watershed area. Erosion of the scar produced considerable colluvial material that was deposited within the drainage and at a debris fan at the mouth of the drainage near Red River. Presently, surface water from the greater part of the upper drainage is intercepted by the open pit. The open pit collects storm water from the existing pit walls, surrounding areas above the pit walls, roadside rock pile drainages (i.e., 8920 and 8720 Diversions), and perched groundwater seepage within its closed basin. The runoff collects in the bottom of the pit (elevation of 8,350 feet) in an intermittent pond where it infiltrates into the old underground workings, which range in elevation from 7,800 feet to near the bottom of the open pit. Infiltration of the water is enhanced by rises within the old underground workings that connect various levels. A vertical borehole was drilled near the end of the decline that connects the old underground workings to the active underground mine. Water collected from the old underground workings is managed in the active underground mine and pumped to the mill via the decline and neutralized at the mill.

Blind Gulch is a sub-drainage in the upper Sulphur Gulch drainage and it has been filled with waste rock. Spring Gulch is another sub-drainage to Sulphur Gulch that has been filled by mine rock. The Sulphur Gulch Rock Pile (also referred to as Sulphur

Gulch South) was constructed within the lower drainage of Sulphur Gulch with rock thickness reaching approximately 300 feet. Prior to construction of the rock piles, water flowed to the center of the drainage, while currently runoff flows through rills on the rock pile surface or is collected and diverted by roadside ditches.

The overall watershed area of Sulphur Gulch is essentially the same as it was prior to large-scale mining. Most of the precipitation within the Sulphur Gulch drainages and rock piles either evaporates or infiltrates to the groundwater system. No seepage has been observed at the base of Blind, Spring, and Sulphur Gulch rock piles. Only during large rainstorms is surface water runoff generated, which is directed by roadside diversion ditches to the open pit or to the North Detention Basin. The North Detention Basin is designed to collect runoff from portions of the Blind Gulch Rock Pile and northeast-facing slopes of the Sulphur Gulch Rock Pile near the open pit, totaling a drainage area of approximately 51 acres. Water is pumped through a pipeline to a diversion channel that leads to the edge of the open pit. Storm water directed to the open pit either evaporates or infiltrates to be collected as inflow to the underground workings. The water collected underground is pumped to the mill via the decline and used in operations and pipeline maintenance. Runoff that does occur at the lowermost Sulphur Gulch Rock Pile evaporates or infiltrates at the base of the rock pile, where earthen berms prevent the runoff and sediment from entering the Red River.

2.2.2 Goathill Gulch

The Goathill Gulch watershed is located within the central portion of the mine site. Nearly the entire length of Goathill Gulch runs through hydrothermally altered scar areas or is closely bordered by scar areas. The total plan-view area of exposed scar material covers about 20 percent of the total watershed area. Like Sulphur Gulch, Goathill Gulch has a debris flow fan at its mouth that is made up of eroded colluvium and scar material.

Overburden has been placed in the Goathill North Rock Pile in the upper reaches of the drainage during development of the open pit mine. Most of the precipitation falling on the rock pile infiltrates and issues at the base of the rock pile as seepage. The seepage flow is typically between 4 and 20 gpm.

The primary change in hydrology of Goathill Gulch has been the development of a subsidence zone overlying the underground workings, which is a result of block-caving mining techniques. The subsidence area is an approximate 1,000-foot wide depression that now collects all stream flow and shallow groundwater of Goathill Gulch upstream of the subsidence area inclusive of the seepage from Goathill North Rock Pile. The water collects in the depression and infiltrates into the underground workings via cracks and fractures created by collapse and deformation of the rock. Water that enters the subsidence zone enters the underground mine, where it is managed and pumped to the mill via the decline. A beneficial aspect of the subsidence zone is that it prevents any storm water or associated groundwater from flowing to the Red River.

Goathill Gulch also receives water that is pumped from the Capulin Canyon seepage collection system. This seepage from the base of the Capulin Rock Pile is discharged via a pipe to below the base of Goathill North Rock Pile, where it combines with water from the upper Goathill Gulch drainage and flows into the subsidence zone.

Storm water catchments are located downgradient of the subsidence zone near the administration buildings. These catchments collect storm water runoff from the watershed below the subsidence zone in the lower portion of Goathill Gulch, just north and west of the Administration Building. The catchment system collects water only during moderately intense rainstorms; otherwise, the catchment system is dry. These catchments are earthen-lined, and collected water eventually evaporates or infiltrates. These catchments are associated with Outfall 004, which is the NPDES permitted discharge point, in the event that storm water exits this system. There has been no discharge from this outfall since 1993.

A smaller sub-watershed joins Goathill Gulch at its lower reach and is referred to as Slick Line Gulch. An earthen-lined catchment is located downstream of the Sugar Shack West and Goathill South rock piles along two drainages of Slick Line Gulch. This catchment is designed as a flow-through basin and does not collect storm water.

2.2.3 Capulin Canyon

Capulin Canyon is the westernmost watershed at the mine site. A scar is present on the west-facing slopes in the lower portion of the drainage. The scar covers about 3 percent of the total watershed area. A debris flow fan protrudes from the canyon as it joins the Red River. The debris fan contains some amount of altered scar material.

Overburden was placed in the Capulin Rock Pile in the uppermost reaches of the drainage during development of the open pit mine. The hydrology of this area was purposely modified by construction of a seepage collection system in the headwaters of the Capulin Canyon. The system collects seepage within a small lined catchment that originates from the rock pile. This water is pumped through a nearly horizontal borehole drilled through the ridge between Capulin Canyon and Goathill Gulch, where it flows into the subsidence area and then into the underground mine workings. There it is managed and pumped to the mill via the decline. The seepage flow rate at the base of the rock pile typically ranges from 5 to 20 gpm. Downstream of the collection system, there is no year-round stream flow. Some small seepage from side drainages may occur, but the water quickly infiltrates. Stream flow only occurs during large rainstorms.

Two storm water detention basins are located near the mouth of Capulin Canyon. The two catchments are designed to collect storm water runoff in the upper portion of the canyon. The watershed downstream of the seepage collection system drains mineralized terrain and a hydrothermal scar, and runoff from these areas flows into the detention basins near the mouth of the canyon. No water discharges from these basins.

2.2.4 Roadside Rock Pile Drainages

Three drainages from the mine occur between the mill and Columbine Creek. Mine rock has been placed in each drainage forming the Sugar Shack South, Middle, and Sulphur Gulch South rock piles, collectively referred to as the roadside rock piles. A healed hydrothermal scar is believed to be below the mine rock within the Middle drainage (Nordstrom 2008).

Storm water runoff from each of the roadside rock piles is collected at the base of the rock pile by earthen-lined berms. The berms lie between the base of the rock piles and Highway 38. Water that collects at the base of rock piles infiltrates through the coarse fill material and rock used to construct the catchments or evaporates. No seepage from the rock piles has been observed. During fall 2006, enhancements were made to the storm water collection along the base of these rock piles. Rock pile berms at the base of each rock pile were raised as much as 30 feet, and the storm water catchments were re-contoured to collect runoff from below the first bench to the base of the rock piles.

2.2.5 Mill

Storm water in the mill area drains to two catchments: the earthen-lined 005 Mill Yard catchment near the laboratory and the concrete-lined Mill Yard catchment near the Mill Complex. The mill area is broad and flat, and much of its surface is compacted or impervious. The lower end of the 005 Mill Yard catchment is equipped with a submersible pump that is activated by a float mechanism. When the water reaches a high enough level, the pump is activated and the water is pumped to the mill for use as make-up water. Although this catchment should theoretically discharge out of Outfall 005, there has been no discharge from the outfall since 1993 and consideration is being given to either eliminating the outfall or designating it for some other purpose.

2.3 Capture Zone

Dewatering of the underground mine creates a zone of depressed water levels in the bedrock surrounding the underground mine that prevents water entering the mine workings from migrating to the alluvial aquifer and the Red River. Hydraulic connections between the mine workings and the open pit and subsidence zone in Goathill Gulch also cause a depression of water levels within the bedrock aquifer. Bedrock water within this zone of depression (capture zone) ultimately flows to the underground mine workings. The estimated extend of the capture zone is shown on **Figure 1**. The dewatered elevation in the underground mine is approximately 7,120 feet. This elevation is approximately 500 to 900 feet below the elevation of the Red River, which ranges from 7,600 to 8,000 feet.

Several lines of evidence for capture (both physical and chemical data) were use to estimate the extent of the capture zone, which are contained in the RI report. The bedrock capture zone encompasses approximately half of the mine area, centered in the middle of the mine. Water infiltrating into the bedrock within this zone flows into the underground mine, where it is managed, pumped to the mill via the decline, and neutralized at the mill. The average daily pumping rates from the underground mine measured over the last several years is approximately 250 gpm. When compared to the amount of groundwater estimated to be flowing within the mine site of approximately 520 gpm (estimated from a watershed yield analysis as part of the RI), the underground mine is collecting approximately half of the available groundwater flow within the mine boundary. This water is prevented from leaving the mine and does not reach the alluvial aquifer or the Red River.

2.4 Evaluation of BMPs and Storm Water Management

The following sections evaluate the BMPs and storm water controls at the mine site and their effects on the potential for mine water to reach and possibly impact the water quality of the Red River.

2.4.1 Constituent Load Removed by BMPs

Groundwater loading from mine site rock piles was analyzed as part the RI/FS to evaluate the effectiveness of CMI's BMPs. Loading represents the mass flow rate of constituents in groundwater. Loading estimates are used with an understanding of the source and transport flowpath to assess potential water quality impacts to receiving waters. The receiving water used in the loading analysis is the Red River alluvial aquifer. Loading was analyzed for those rock piles where constituent loads have the potential to migrate to the alluvial aquifer and impact the water quality of the Red River, which includes all rock piles except Capulin and Goathill North.

The first component of the analysis included estimating the constituent loads from the rock piles. This was accomplished by multiplying the flow or infiltration rate through the rock pile (Golder 2005 and 2006) by representative concentrations of constituents in the water moving through or beneath the rock pile observed in monitoring wells. The second component of the loading analysis was to estimate the load removed by CMI's BMPs along the roadside rock piles. The BMPs address potential loading from the roadside rock piles by operation of a groundwater withdrawal well system that consists of three extraction wells (GWW-1, -2, and –3). Chemical data from the wells and measured flow rates were used to estimate the load removed by the system. The last component of the loading analysis was a comparison of the estimated load from rock piles that has the potential to migrate and enter the Red River alluvial aquifer to the load removed by the groundwater withdrawal well system.

The comparison found that, for the five constituents that were evaluated, including aluminum, manganese, sulfate, fluoride, and zinc, the load removed by the groundwater withdrawal system is about two times greater than the rock pile load under a moderate precipitation scenario. Under a high precipitation scenario, the load removed by the groundwater withdrawal system is similar and slightly less than the rock pile load. Overall, the groundwater withdrawal system is effective from a pumping and load-removal perspective. The groundwater withdrawal system is removing metals and inorganic mass from the alluvial aquifer that may otherwise continue to migrate downgradient and enter the Red River in areas known to have groundwater upwelling such as Columbine Park. This load reduction is greater than the load from the rock piles under average, long-term precipitation conditions.

This same loading analysis and effectiveness evaluation was performed in 2006 (URS 2006) and submitted to EPA as part of the previous NPDES renewal application. The

BMP effectiveness evaluation was approved and used by EPA at that time to respond to stakeholder comments on the renewal application.

In December 2010, EPA issued the Record of Decision (ROD) for the Questa Mine that includes additional groundwater extraction near the mouth of each site drainage. This will remove additional constituent loads beyond the existing BMPs and will further reduce any hydraulic connection between the mine and the Red River. The ROD also includes maintaining the water elevation in the underground mine below the elevation of the Red River. Therefore, this hydraulic control of groundwater will continue during and after mine operations.

2.4.2 Storm Water Controls

The storm water management systems at the mine site, previously discussed in Section 2.2, are designed to limit the amount of mine water that can potentially reach the Red River. Storm water controls have ensured that runoff does not discharge from the mine to the river, which is supported by direct observations made in the RI during multiple storm event sampling efforts in summer 2003. The storm event sampling included observation of each mine site drainage for evaluation of potential discharge to the river. Of the five storms that were observed, one of which produced approximately 1.5 inches of rainfall at the mine, storm water discharge to the river was not observed. Observations by CMI personnel are ongoing as required under the SWPPP, and no storm water discharges to the river have been observed.

2.4.3 Red River Water Quality

Another measure of the effectiveness of the BMPs and storm water management at the mine site is the water quality response in the Red River adjacent to the mine. The Red River is currently on the 303 (d) (1) listing of impaired waters in New Mexico for which it has been assigned a Total Maximum Daily Load for aluminum to control acute aluminum exceedances. Using aluminum as the primary indicator constituent for the health of the river, historic aluminum (total) concentrations near the downstream mine boundary at monitoring location RR-14 were graphed to illustrate the behavior of aluminum over time (**Figure 2**). The earliest available sample data at RR-14 date back to November 1988 and the location has been subsequently sampled on a quarterly basis as a requirement of DP-1055, issued by the New Mexico Environment Department (NMED). The RR-14 sampling location represents the cumulative inputs along the mine combined with inputs upstream of the mine, which are known to contain naturally elevated levels of aluminum at times due to acidic runoff from natural hydrothermal scars. Also shown on the aluminum graph are the acute and chronic aluminum criteria based on the 2010 New Mexico Water Quality Control Commission's (WQCC) criteria (New Mexico Administrative Code [NMAC] 20.6.4.900 effective December 1, 2010), using a typical hardness value at RR-14 of 150 mg/L. These New Mexico criteria are anticipated to be approved by EPA. Times at which BMPs and storm water controls at the mine were implemented or upgraded are indicated on the graph.

As illustrated on **Figure 2**, aluminum concentrations have decreased over time. Aluminum concentrations in the mid 1990s were typically between 2 and 5 mg/L and have decreased to values that typically range from 0.5 to 1.5 mg/L since 2008. Aluminum concentrations entering the mine site reach at RR-7 near the upstream mine boundary (**Figure 1**) ranged from 0.3 to 1.4 mg/L since 2008, exemplifying the natural impairment of river quality from sources upstream of the mine.

A linear trend line was fitted to the aluminum concentrations, which indicates a decreasing trend over time with a moderate coefficient of determination (R^2) of 0.56. The coefficient of determination is a statistical measure of the variability in the data set that is accounted for by the trend line. The decreasing trend in concentrations is likely due to the BMPs and storm water management controls that have been implemented by CMI beginning in the early 1990s. These controls initially included construction of catchments in lower Goathill Gulch and at the mill, and construction and operation of the Capulin Canyon collection system near the base of the Capulin Rock Pile in the early 1990s. This was followed by additional enhancement of these controls and new storm water controls at the roadside rock piles and other drainages in the mid 2000s, as well as interception of waters from Springs 39 and 13. Climatic effects are not responsible for a significant portion of the decreasing trend because both wet cycles (1997 to 1999 and 2006 to 2009) and dry cycles (2000 to 2002) are within the timeframe and their potential effects on water quality are not apparent.

Two notable observations are concluded from the aluminum graph relative to the Red River.

1) Over-the-winter aluminum concentrations in the river have decreased. During the fall through early spring, the proportion of stream flow from groundwater increases. Because aluminum has decreased during this portion of the year, groundwater quality is either improving or the hydraulic connection between groundwater and the river has been reduced. The BMPs are likely to be responsible for both the improvement in groundwater quality and reduction in

hydraulic connection, resulting in the observed improvement in the river's water quality.

2) Since summer 2007, aluminum concentrations in the Red River at the downstream boundary sampling location have been below the 2010 New Mexico chronic aquatic life criterion. Based on the observed decreasing trend in concentrations and continued operation of CMI's BMPs and storm water controls, aluminum is expected to remain below the chronic criterion. EPA's selected remedy that includes additional groundwater extraction in each drainage should ensure that the aluminum criteria are not exceeded, except when episodic runoff from hydrothermal scar drainages upstream of the mine occurs.

2.5 Summary

The BMPs and storm water controls at the mine site have resulted in an improvement in the river's water quality over the last two decades. Significantly decreasing trends in constituent concentrations have been observed in the river at the downstream boundary of the mine to a point that the 2010 New Mexico chronic aquatic life criterion for aluminum has not been exceeded since 2008. The hydraulic connection between the mine and the river that may remain does not result in exceedance of any surface water quality criteria. The ROD for the Questa Mine includes additional groundwater extraction near the mouths of each site drainage, which will further reduce any hydraulic connection.

3. Tailing Facility

An evaluation of the seepage interception system and water management at the tailing facility is presented in this section. Descriptions of the hydrology, water and tailing management, permitted discharges, and the seepage interception system are presented first, followed by the evaluation.

3.1 Hydrology

The tailing facility area was previously drained by two northeast-southwest trending arroyos that are now occupied by the Dam No. 1 and 4 tailing impoundments (**Figure 3**). According to topographic maps of the Questa area near the time at which the first impoundment dam was constructed (1963), the surface water flow in the two arroyos was ephemeral and most likely occurred only during rainstorms or from quickly melting snow in the springtime.

With the construction of tailing impoundments in the two arroyos, two drainage channels were constructed to route storm water around the impoundments for flood control. Both drainage channels were constructed in 1975. The eastern drainage channel borders the Dam No. 1 impoundment and has a catchment area of approximately 1.2 square miles. Irrigation return flows and unused irrigation water from the Llano Ditch and Cabresto Creek Ditch No. 4 flow into this eastern drainage channel. The eastern drainage channel empties into the area just below Dam No. 1, after which water would flow southwest to the Red River. The western drainage channel borders the western side of the Dam No. 4 impoundment and has a catchment area of 5.4 square miles. The western drainage channel empties into the area just south of Dam No. 4 and ultimately would flow into the Red River, if there were a sufficient volume. Peak discharges for the 100-year 24-hour precipitation event were estimated for the western drainage channel at 2,070 cubic feet per second (cfs) and 450 cfs for the eastern drainage channel. However, storm flow in the western channel has never been observed and storm flow in the eastern channel has been minimal.

Several irrigation ditches and smaller laterals traverse the Questa area and deliver water from either Cabresto Creek or Red River to fields and pasturelands adjacent to and downstream of the tailing ponds. Water that is not consumptively used by the crops or grasses is available to percolate and enter the groundwater system. Additionally, most of the irrigation ditches are not lined, thereby allowing substantial water to seep through the earthen ditch bottoms. Because the shallow groundwater flow direction is generally toward the south and southwest, the irrigation return water eventually flows south of the tailing facility and discharges to Red River downgradient of the tailing impoundments. A considerable amount of irrigation water flows directly into the Red River south of the tailing facility because the North and Middle ditches terminate in fields, and any unused irrigation water is allowed to flow overland to the river.

3.2 Water and Tailing Management

Over the past 40 years, tailing have been delivered to the impoundments when the mill is operating. This has resulted in tailing that covers a total area of approximately 1 square mile. The tailing water slurry typically is composed of approximately 38 percent solids and 62 percent water by weight. Currently, tailing is discharged to the Dam No. 4 impoundment when the mill is operating. Water was also impounded behind Dam No. 1 and had been maintained for suppression of dust. Only process water (no tailing) has been discharged behind Dam No. 1 since 1986. However, CMI no longer discharges process water to this area of the impoundment and it is dry as of the close of 2010. When the mill is not operating, water is run through the tailing pipeline for maintenance purposes and discharged to the Dam No. 4 impoundment. In 2005, CMI began construction of earthen berms within the Dam No. 4 impoundment to compartmentalize the discharged tailing in an effort to maintain a more effective cover of water for suppression of dust.

3.3 Permitted Discharges

CMI discharges collected groundwater and tailing seepage to the Red River under NPDES Permit. No. NM0022306. Two permitted outfalls currently exist at the tailing facility. Outfall 001 is the outlet of Pope Lake near the base of Dam No. 4. In the past, water from the impoundments was decanted to Pope Lake, where it was treated by an ion exchange treatment plant. The treatment plant began operation in 1983, and the treated water was discharged to Red River from an outfall below Pope Lake. The plant has not operated in many years, and there has been no discharge through the 001 Outfall since 1990 – i.e., over 20 years of no discharge.

The 002 Outfall is the largest permitted discharge from the tailing facility and is a continuous discharge. Outfall 002 discharges a mixture of natural groundwater and tailing seepage from a series of extraction wells and seepage barriers south of Dam No. 1. A third outfall (003) was part of the original permit, but is now an extension of the Outfall 002 system and includes an extraction well and two seepage barriers on the eastern flank of Dam No. 4 that discharge into and become part of the Outfall 002 discharge. The combined water flows via gravity through a pipeline and discharges at Outfall 002 along the bank of Red River. The extraction wells account for approximately 20 percent of the total discharge, and the seepage barriers account for the remaining 80 percent. In 2010, the Outfall 002 discharge rate ranged from 275 to 350 gpm.

3.4 Seepage Interception System

CMI operates a seepage interception system south of the Dam No. 1 impoundment. The system began operation in 1975 and is designed to intercept tailing seepage originating from the tailing impoundment. The system consists of a combination of shallow rock-filled drains, seepage barriers, and extraction wells. The collected water flows into a pipeline via gravity to a concrete manhole, where all waters combine and then flows approximately 1,500 feet to where the pipeline discharges on the bank of the Red River. A plan view of the system layout is shown on **Figure 4**. In 2009 and

2010, the Outfall 002 discharge pipeline leading to the river was slip-lined to ensure its integrity, and other system pipelines were replaced.

The system's performance was evaluated in 1998, which was a requirement of DP-933 at that time. Based on the results, the collection system created sufficient drawdown to capture most of the seepage before reaching the southern property boundary. The highest constituent concentrations occurred in the EW-5 series of wells and decreased downgradient.

In fall 2003, CMI installed a pumpback system to reduce the manganese load discharged at Outfall 002. The pumpback system consists of a new manhole located approximately 750 feet north of the existing Outfall 002 manhole. The collected water is pumped northward over Dam No. 1 and discharges at Dam No. 5A. The pumpback system became operational in January 2004, and its discharge rate averaged approximately 70 gpm in 2010.

3.4 Evaluation of Seepage Collection

The following sections evaluate the seepage collection at the tailing facility and its effect on the potential for tailing seepage to reach and impact the water quality of the Red River.

3.4.1 South of Dam No. 1

A requirement of DP-933 (modified and renewed on February 29, 2008) is to evaluate the effectiveness of the seepage interception system annually. The 2010 evaluation (ARCADIS 2010) found that the system is effective at collecting most of the seepage from the Dam No. 1 impoundment before reaching the southern property boundary. Tailing seepage may have bypassed the system due to leaking pipelines and incomplete capture; however, constituent concentrations downgradient of the system are not elevated to a significant degree and undergo natural attenuation. The Outfall 002 discharge pipeline was lined and other system pipelines were replaced in 2010; therefore, leakage should not occur in the future. The selected remedy in EPA's ROD for the tailing facility includes enhancements to the Outfall 002 seepage collection system, which will further reduce the hydraulic connection between the impoundment and the Red River.

3.4.2 South of Dam No. 4

Water balances for the tailing facility have been prepared based on information from monthly water usage reports that CMI submits to the New Mexico Office of the State Engineer. The water balances account for the amount of water delivered to the tailing facility, evaporative and retained moisture losses, and seepage collected by the seepage interception system south of Dam No. 1. The remaining amount of water infiltrates into the volcanic aquifer beneath the Dam No. 4 impoundment. Water balance calculations performed for the RI estimated that average water stored in the impoundments that is potentially available to infiltrate into the volcanic aquifer in 2003 was 2.9 cfs and 5.5 cfs in 2006. Water usage records for 2009 indicate that this rate decreased to 3.1 cfs, which is similar to the average rate in 2003. It is important to realize that not all of this water infiltrates and is stored in the impoundment and carried over from month to month. A portion of the water is collected by the seepage collection system on the eastern flank of Dam No. 4.

According to EPA's ROD, the selected remedy for the volcanic aquifer beneath the Dam No. 4 impoundment is monitoring only; no active remediation. The basis for this decision, which allows for natural attenuation, is that there is minimal groundwater use and exposure south of Dam No. 4. These conditions are expected to continue for the foreseeable future.

3.4.3 Red River Water Quality

The effectiveness of CMI's seepage interception system and water management at the tailing facility was evaluated by the water quality response in the Red River south and downgradient of the tailing facility. The Red River was sampled at several locations along the reach south of the tailing facility during the RI. Two of these locations are used to evaluate the potential water quality impacts of the tailing facility on the river (**Figure 3**). One sampling location (RR-20) is located upstream of the tailing facility and another (LR-13) is downstream of the Dam No. 4 impoundment within the Red River Gorge. Both locations were sampled four times during the RI (2002 through 2003), spanning times of seasonal high and low flows in the river. The two locations have not been sampled since that time. Although the sampling was performed 8 years ago, the trends in water quality are expected to represent current conditions because the estimated amount of seepage infiltration from the impoundments and operation of the seepage interception system today are similar to conditions during the 2002 to 2003 timeframe. The permitted Outfall 002 from the tailing facility discharges between the two locations. The following presents an evaluation of the water quality of the river along this reach, using aluminum, manganese, and molybdenum to illustrate the tailing facility's potential impacts on the river.

Figure 5 is a graph of aluminum (total) for the upgradient and downgradient river sampling locations. Both the 2010 New Mexico acute and chronic aquatic life criteria (NMAC 20.6.4.900 effective December 1, 2010) are also shown on the graph. These criteria are based on a hardness value of 200 mg/L, which is typical for this reach of the river. Aluminum concentrations for the four sampling events illustrate that there is a decrease in the aluminum concentration through this reach downgradient of the tailing facility, evidenced by the lower values at the downstream location LR-13. Aluminum concentrations are below both acute and chronic criteria. Present-day aluminum concentrations are expected to be similar to or lower than those in 2002 and 2003 based on the decreasing trend in concentrations at the downstream mine boundary that are now lower than the 2002 to 2003 timeframe (see **Figure 2**). The reach of the river south of the tailing facility is known to be a natural groundwater discharge zone where the river gains stream flow from groundwater from the southern Questa area. Tailing seepage has a neutral pH and very low to non-detected concentrations of aluminum; therefore, any potential seepage that may reach the river will likely dilute aluminum concentrations instead of increasing them.

Manganese is an indicator constituent of tailing seepage. **Figure 6** is a graph of dissolved manganese concentrations for the four sampling events. Like aluminum, manganese concentrations decrease through this reach of the river, illustrated by lower values in the downstream location LR-13 compared to the upstream location RR-20. Therefore, any potential hydraulic connection of the tailing facility with the river results in a dilution of manganese concentrations in the river. Manganese concentrations are below the 2010 New Mexico acute and chronic criteria. It is noteworthy that the permitted Outfall 002 discharges collected groundwater and seepage between these two sampling locations, and even with this discharge, manganese concentrations decrease through this reach of the river. It is also noteworthy that, like aluminum, manganese concentrations have decreased in the river along the mine site since the 2002 to 2003 timeframe. Thus, current manganese concentrations along the tailing facility are expected to be lower than those shown on the graph.

Another indicator constituent in tailing seepage is molybdenum. Concentrations from the four sampling events are shown on **Figure 7** (note the logarithmic scale). Molybdenum concentrations in the river increase through this reach of the river illustrated by the higher concentrations at the downstream sampling location LR-13. Outfall 002 discharges between the two sampling locations, likely resulting in the increased molybdenum concentrations. Groundwater discharging to the river is not the cause of this increase, evidenced by CMI sampling of the river immediately upstream (LR-5) and downstream (LR-8A) of the Outfall 002 discharge at the river, which show a similar magnitude of increase in concentration, indicating that the increase in molybdenum concentrations is primarily from Outfall 002. Although molybdenum concentrations increase in the river, values are one to two orders of magnitude lower than the 2010 New Mexico chronic and acute aquatic life criteria, respectively.

CMI sampled the Red River south of the tailing facility in March 2011 to obtain current water quality information and to assess the potential hydraulic connection with the river. Sampling locations LR-5, LR-8A, LR-11A, LR-13, and LR-16 (**Figure 3**) are downgradient (south-southwest) of the tailing facility and were used to assess potential impacts to the river. LR-5 is immediately upstream of the Outfall 002 discharge at the river and the other locations are downstream of the Outfall 002. Locations downstream of the Outfall 002 incorporate the water-quality effects from the permitted discharge. **Figure 8** is a graph of the same three constituents (aluminum, manganese, and molybdenum) at each of the five river locations to illustrate how water quality changes through this reach. Overall, concentrations either decrease or show no appreciable change in concentration. If groundwater with constituents typically present in tailing seepage discharged into the river, concentrations in the river would increase, but they do not. For example, the aluminum concentration decreases from 2.4 to 0.8 mg/L and manganese decreases from 0.26 to 0.18 mg/L. The molybdenum concentration increases between LR-5 and LR-8A, which is solely due to the permitted Outfall 002 discharge, and then is relatively constant downstream of the Outfall 002. The water quality data shows that if there is a groundwater hydraulic connection between the tailing facility and the river, it does not increase concentrations or degrade the quality of the river.

3.5 Summary

The tailing facility is not adversely affecting the quality of the Red River because the river's quality generally improves downgradient of the tailing facility, evidenced by decreasing concentrations of constituents such as aluminum and manganese. Molybdenum is one of the few constituents that increase in the river, but this is solely due to permitted discharges from Outfall 002 and not from groundwater discharging to the river because the seepage interception system was found to collect most of the tailing seepage south of the Dam No. 1 impoundment. Recent sampling of the river found that any potential hydraulic connection between the tailing facility and the river does not increase concentrations in the river or degrades its quality. There are no constituents in this reach of the river that exceed the 2010 New Mexico acute or chronic aquatic life criteria. EPA's selected remedy in the ROD includes enhancements to the seepage interception system, which will further reduce the potential for hydraulic connection between the impoundments and the river. The combination of existing controls and actions required by the ROD for that purpose will continue to be protective of the river's water quality.

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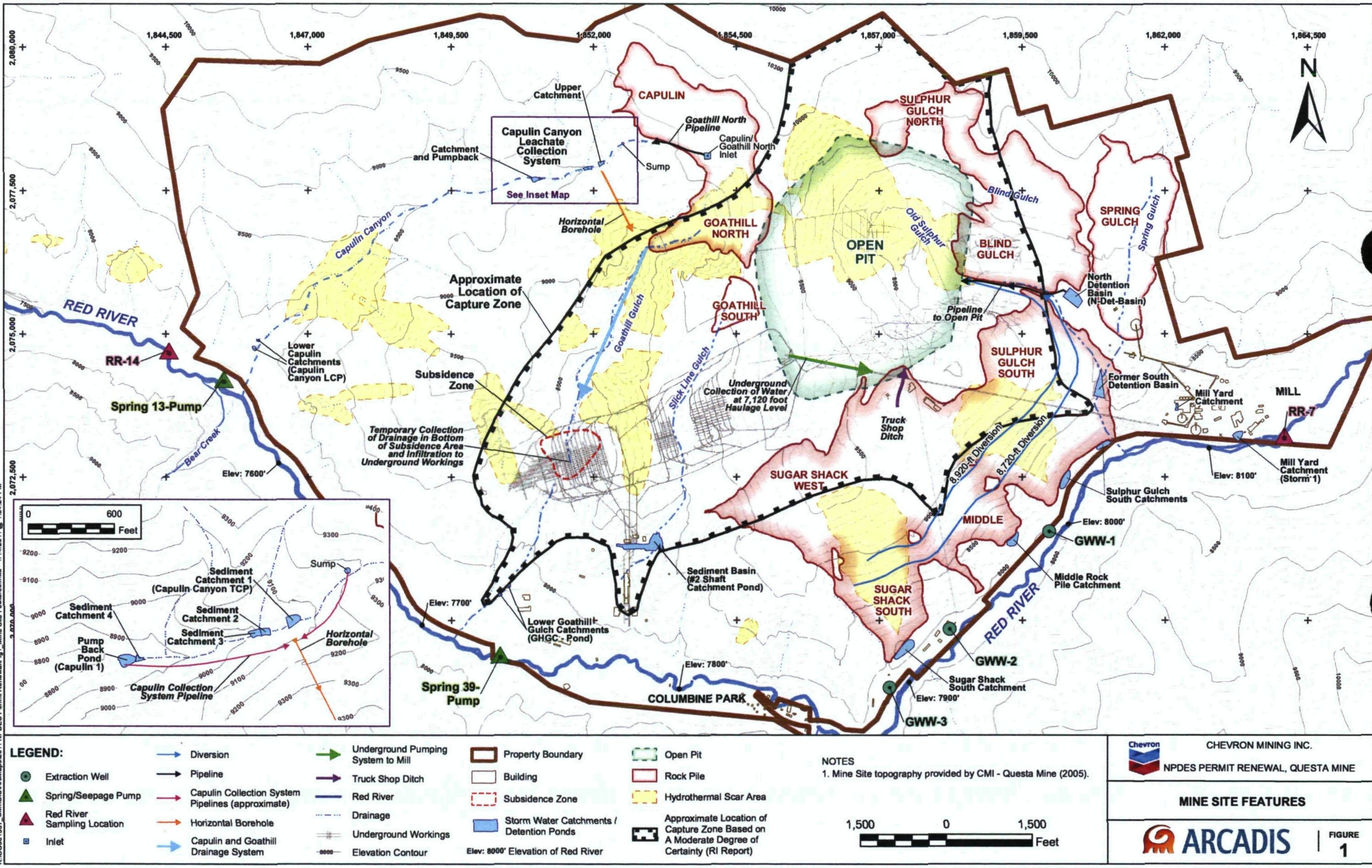
ARCADIS

Evaluation of Best Management Practices and Storm Water Management (Updated)

Figures



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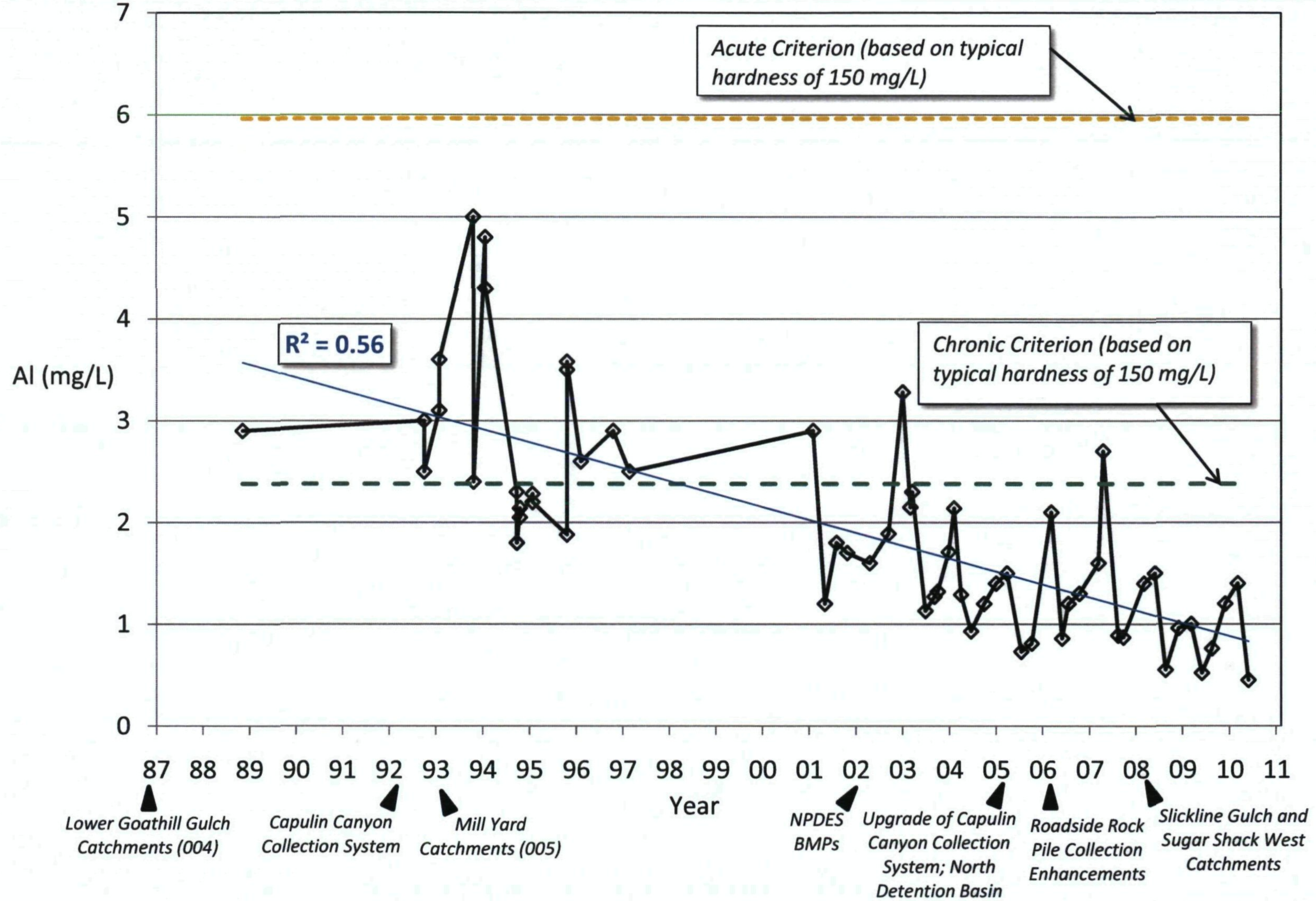

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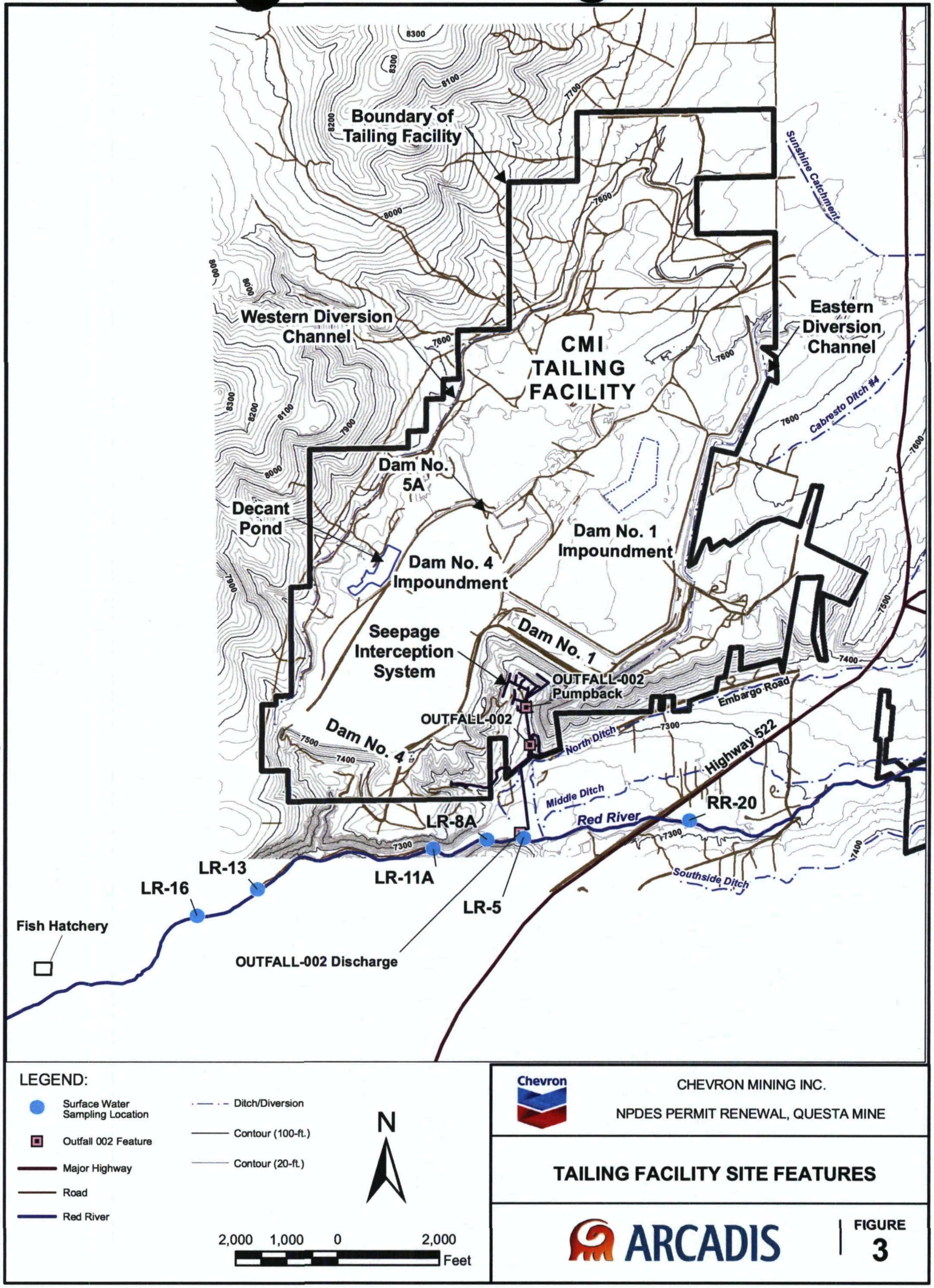
NPDES PERMIT RENEWAL, QUESTA MINE

ALUMINUM (TOTAL) CONCENTRATIONS IN THE RED RIVER AT THE DOWNSTREAM MINE BOUNDARY SAMPLING LOCATION RR-14

ARCADIS

FIGURE 2



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TAILING FACILITY SITE FEATURES

ARCADIS

FIGURE 3

CITY: Boulder, CO DIV/GROUP: AIT DRAFTER: JC
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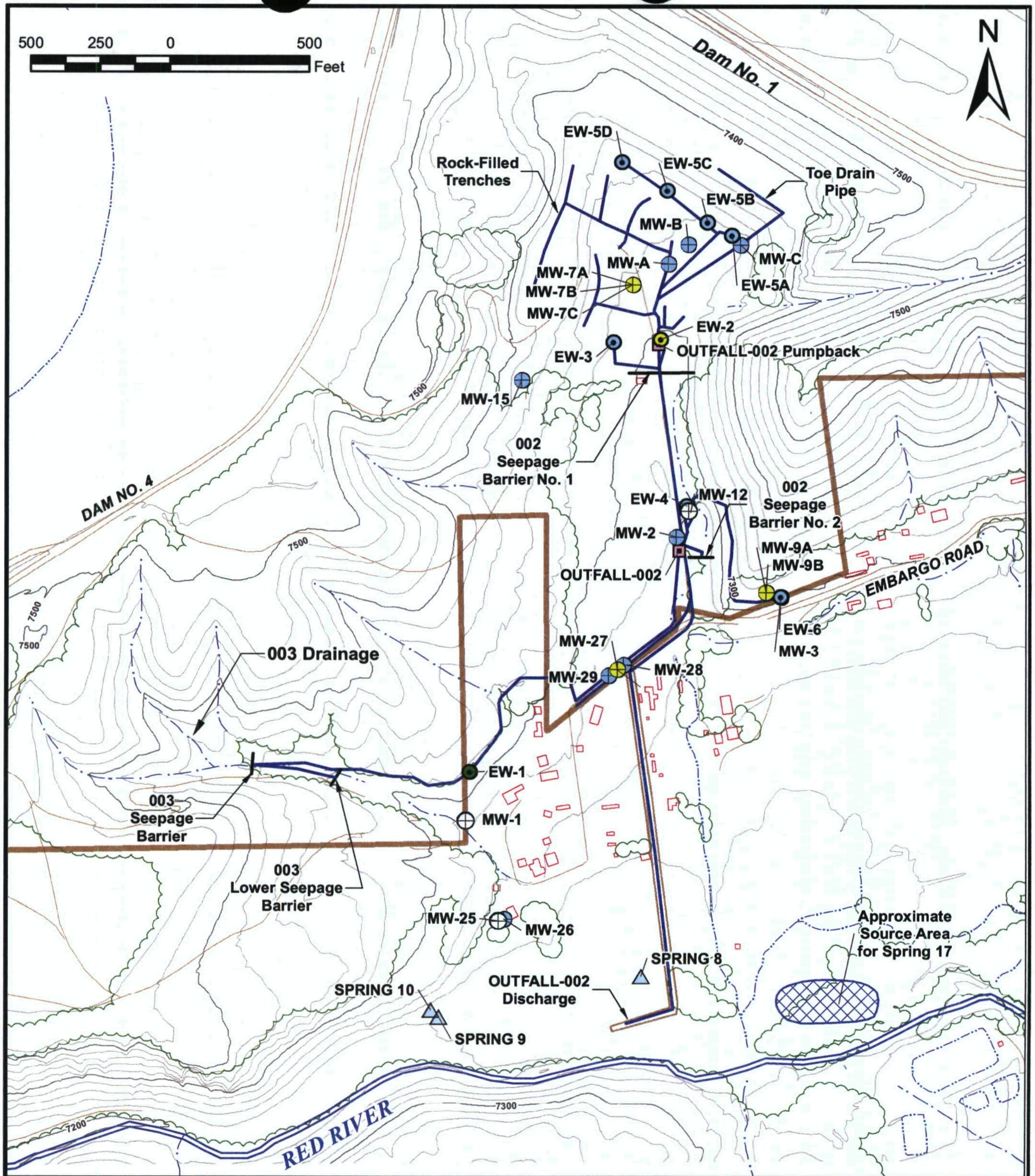

LEGEND:

- Extraction Well - Upper Alluvial
- Extraction Well - Basal Alluvial
- Extraction Well - Basal Bedrock
- Monitoring Well - Upper Alluvial
- Monitoring Well - Basal Alluvial
- Monitoring Well - Basal Bedrock
- Outfall
- Spring
- Seepage Barrier
- Intercept Pipe / Rock Drain
- Easement
- Property Boundary
- Pond
- Drainage
- Red River
- Vegetation
- Buildings
- Contour (100-ft.)
- Contour (20-ft.)
- Spring Source Area

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NPDES PERMIT RENEWAL, QUESTA MINE

PLAN VIEW OF THE TAILING FACILITY SEEPAGE INTERCEPTION SYSTEM

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FIGURE 4

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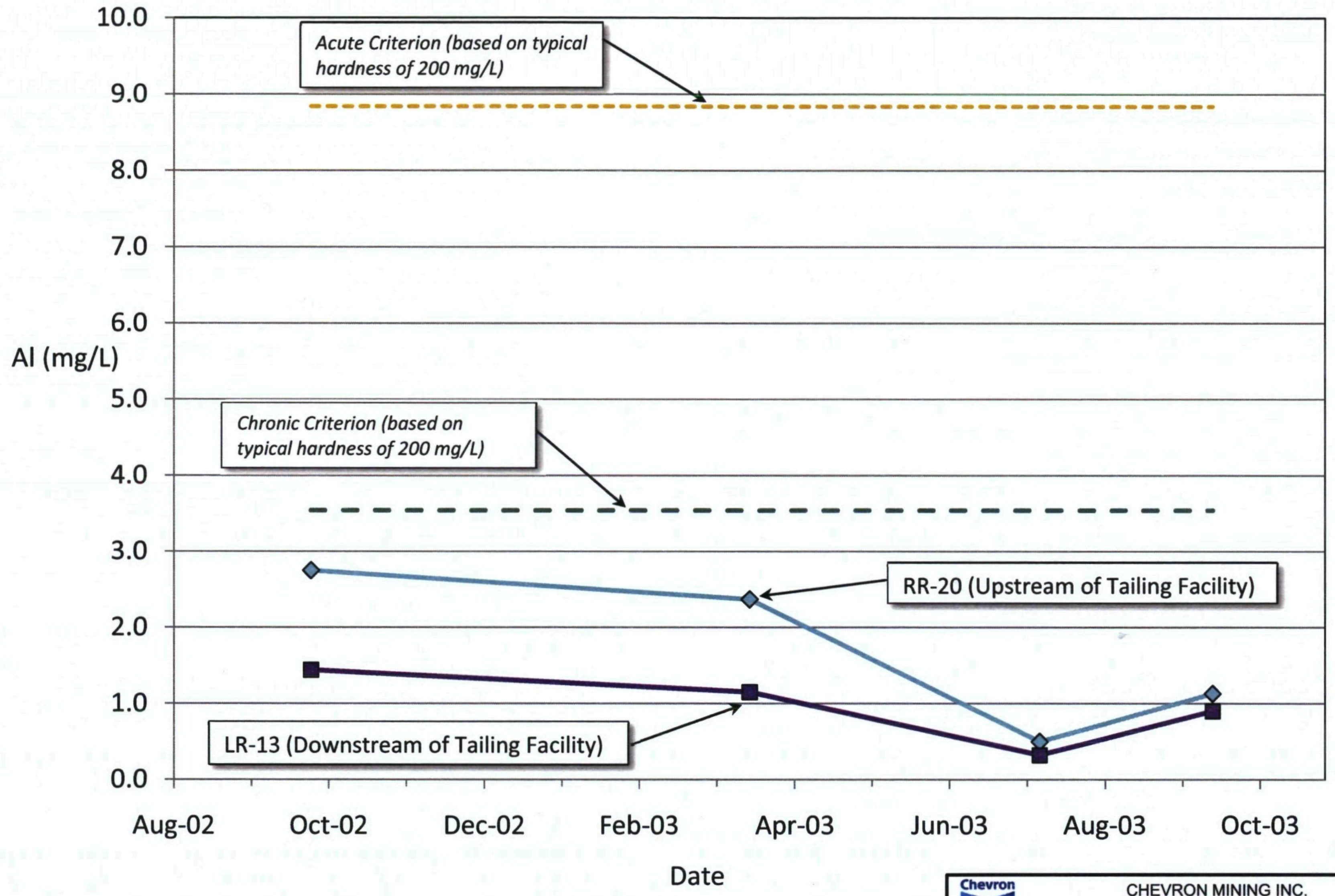

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NPDES PERMIT RENEWAL, QUESTA MINE

ALUMINUM (TOTAL) CONCENTRATIONS IN THE RED RIVER UPSTREAM AND DOWNSTREAM OF THE TAILING FACILITY

ARCADIS

FIGURE 5

CITY: Boulder, CO DIV/GROUP: AIT DRAFTER: JC
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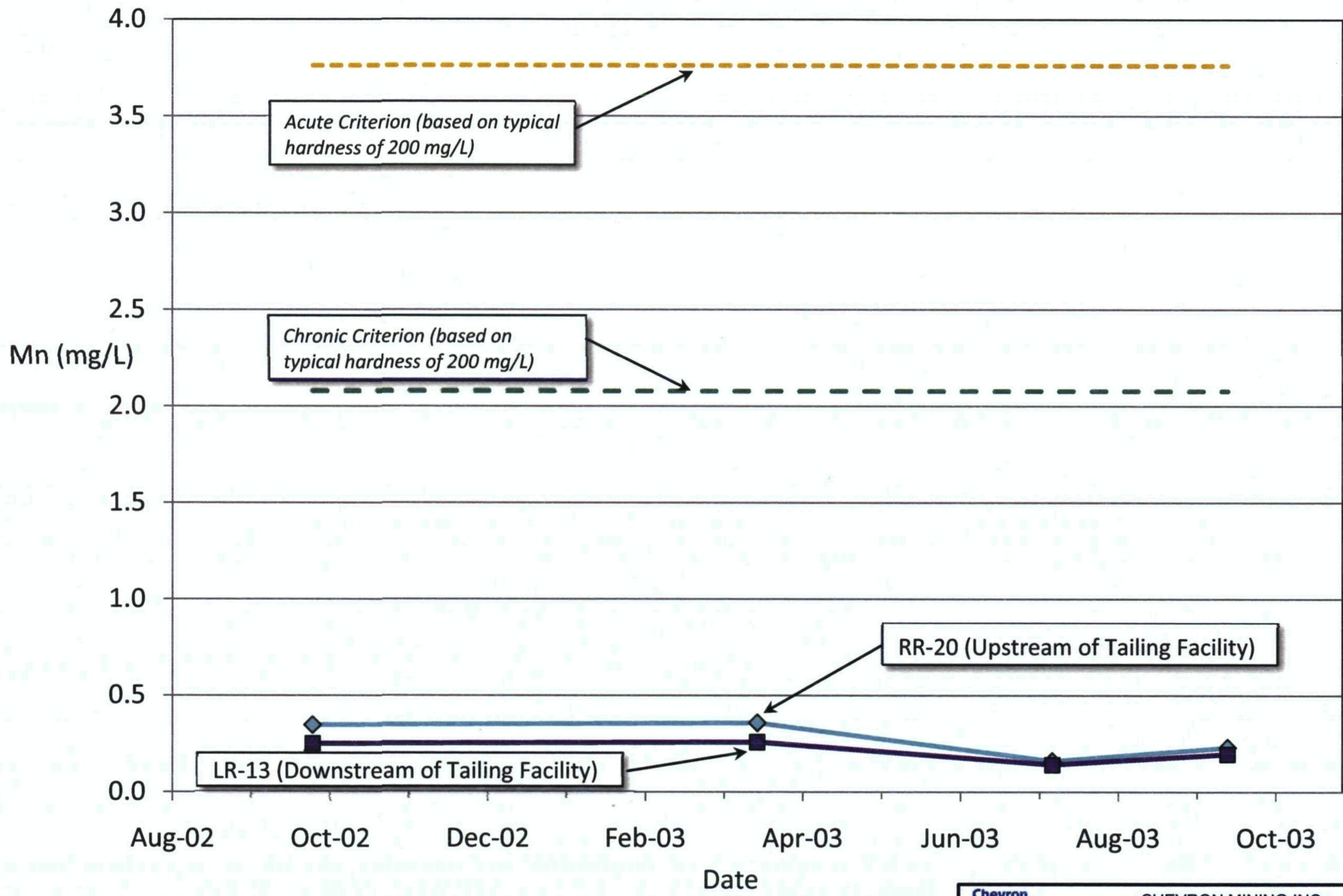

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NPDES PERMIT RENEWAL, QUESTA MINE

MANGANESE (DISSOLVED) CONCENTRATIONS IN THE RED RIVER UPSTREAM AND DOWNSTREAM OF THE TAILING FACILITY

ARCADIS

FIGURE 6

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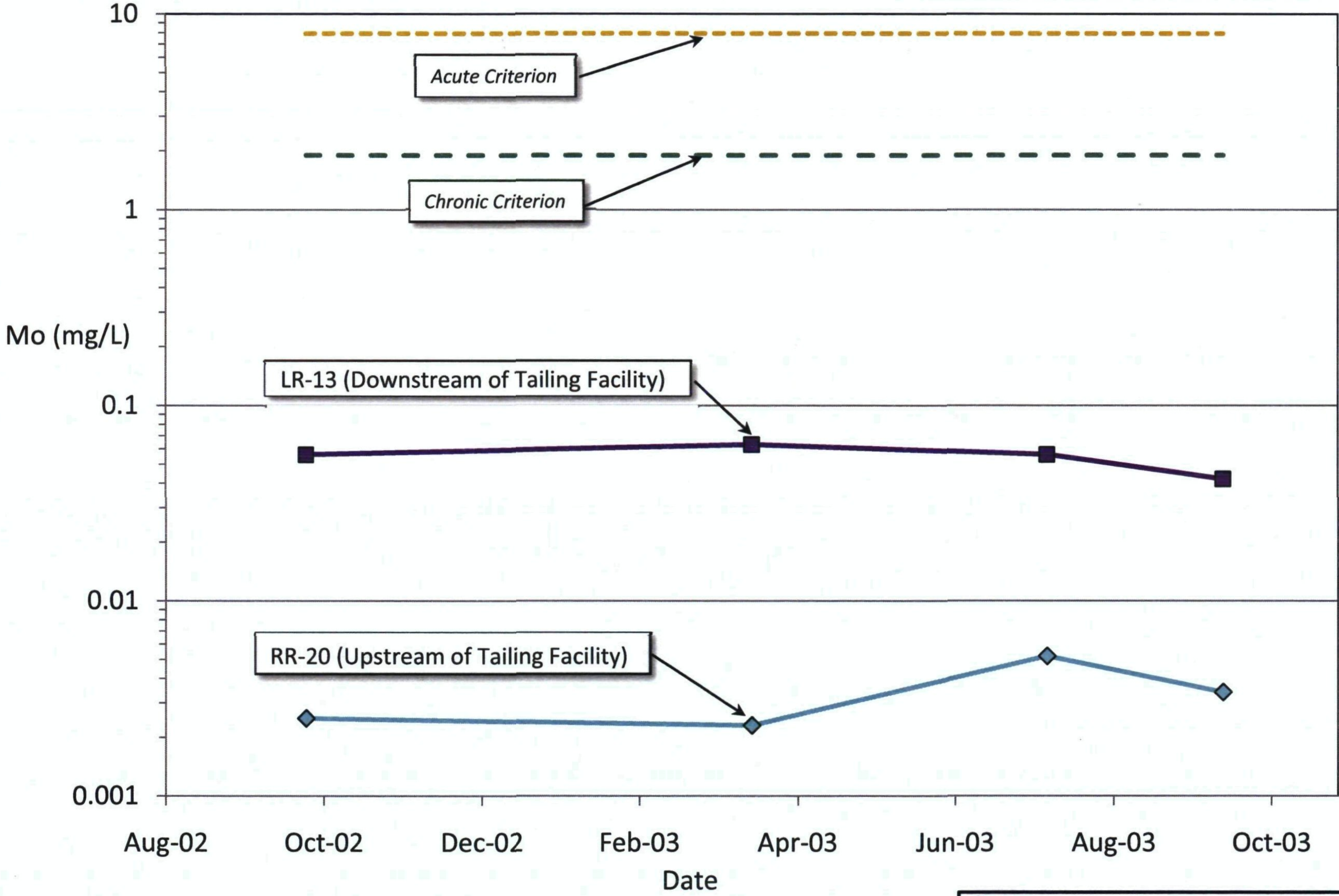

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NPDES PERMIT RENEWAL, QUESTA MINE

MOLYBDENUM (TOTAL) CONCENTRATIONS IN THE RED RIVER UPSTREAM AND DOWNSTREAM OF THE TAILING FACILITY

ARCADIS

FIGURE 7

CITY: Boulder, CO DIV/GROUP: AIT DRAFTER: JC
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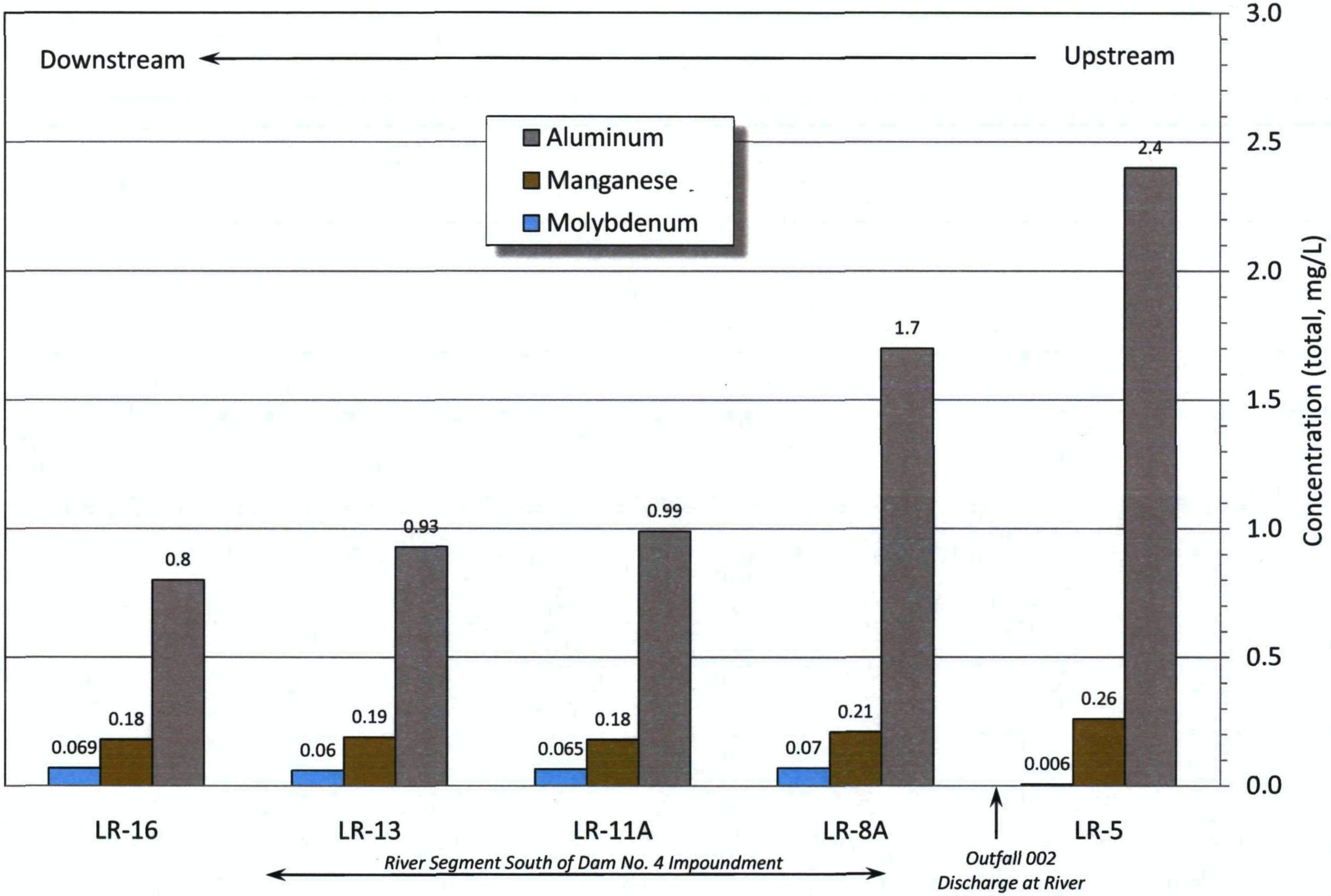

Red River Sample Locations Downgradient (South) of the Tailing Facility

New Mexico Water Quality Control Commission Criteria (NMAC, 20.6.4.900)

Aluminum: Acute = 8.8 mg/L; Chronic = 3.5 mg/L
Manganese: Acute = 3.8 mg/L; Chronic = 2.1 mg/L
Molybdenum: Acute = 7.9 mg/L; Chronic = 1.9 mg/L

Note: Criteria are based on a typcial hardness of 200 mg/L.

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CONCENTRATIONS IN THE RED RIVER SOUTH OF THE TAILING FACILITY - MARCH 1, 2011

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FIGURE **8**

Geotechnical
Environmental
Water Resources
Ecological

GEI Consultants

March 2011

Technical Memorandum

Summary of Red River Biological Monitoring Data, 2002 through 2010, in the Vicinity of NPDES Permitted Outfall 002

1.0 Introduction

This technical memorandum provides a summary of the aquatic biological data collected on the Red River in the vicinity of Outfall 002 in the NPDES permit #NM0022306 for Chevron Mining Inc.'s (formerly Molycorp) Questa mining operations. The information is presented for CMI's NPDES renewal process. Data supporting this renewal report came primarily from long-term aquatic biological monitoring reports by GEI Consultants (GEI; formerly Chadwick Ecological Consultants, Inc. [CEC]) from 2002 through 2010 prepared on behalf of CMI (CEC 2003, 2005a; GEI 2008, 2009, 2010), data collected by the Remedial Investigation (RI) Study as presented in the Molycorp Preliminary Site Characterization Report (URS 2005), and a technical memorandum for the previous NPDES renewal (CEC 2005b).

2.0 Study Area

The current study area includes the Red River from the Town of Red River downstream to just upstream of the New Mexico Department of Game and Fish (NMDGF) Red River Fish Hatchery. The Questa Mine is adjacent to the north bank of the Red River in its middle reaches, between the towns of Red River and Questa. Tailings from the mill are piped to tailings impoundments west of Questa. Groundwater from the base of the tailings impoundments is captured and discharged to the Red River at Outfall 002 (Figure 1).

Outfall 002 is CMI's only NPDES permitted outfall currently discharging on the Red River. The GPS coordinates for this outfall are N36°41'31.36" W105°37'16.58", and it is at an elevation of 7,226 ft. Biological sampling has been conducted and is presented for this report at two sites upstream of Outfall 002 (RR-20 and LR-1) and at two sites downstream of Outfall 002 (LR-8a and LR-16) (Figure 1). During the RI, water and sediment samples were collected at those sites, and at three additional sites (LR-5, LR-11A, and LR-13) downstream of Outfall 002.

GEI Consultants, Inc.
4601 DTC Boulevard, Suite 900, Denver, CO 80237
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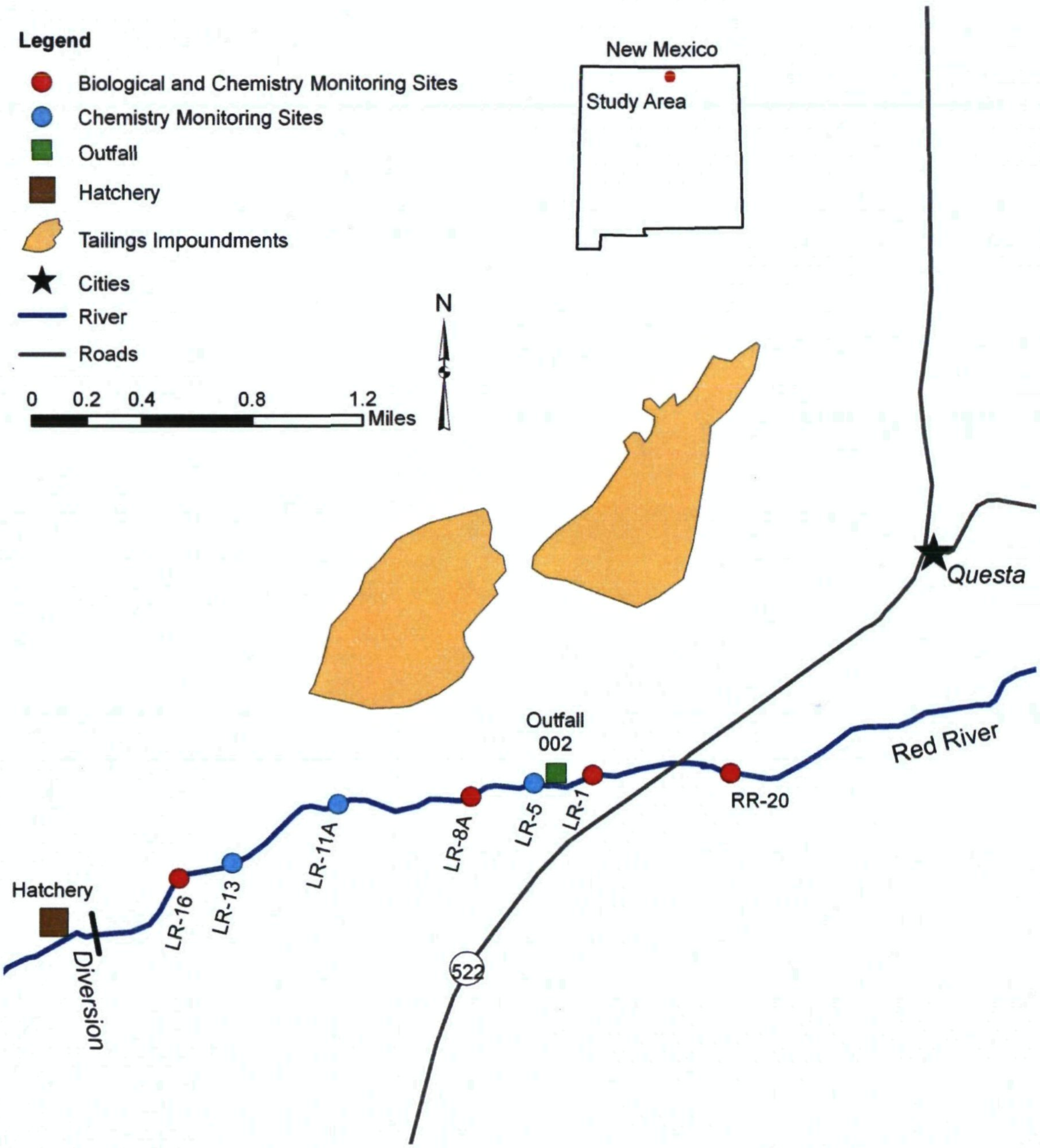


Figure 1: Map of site locations on the Red River in the vicinity of Outfall 002.

3.0 Methods

Fish and benthic invertebrate populations have been sampled at each biological sampling site since 2002. At Site LR-16, data have been collected since 1997. However, data from 1997 through 2001 were not included in this evaluation to allow a more consistent comparison of data between sites.

Fish populations were quantitatively sampled using electrofishing gear and a multiple-pass depletion technique. Fish species captured include rainbow trout, hybrid rainbow/cutthroat trout, brown trout, and white sucker. Rainbow trout found in the study area represent fish stocked by the NMDGF and the Town of Red River. These fish generally do not reproduce successfully in the Red River and therefore rainbow trout are not considered resident fish and are not discussed in this data summary. Benthic invertebrate populations were quantitatively sampled by taking five replicate samples using a modified Hess sampler.

Analysis of variance (ANOVA) was used to determine whether there were significant between-site differences in fish and benthic invertebrate population metrics over the study period (2002-2010). Fish density and biomass, and benthic invertebrate density were $\log_{10}$ transformed to meet the normality and equal variance assumptions for ANOVA. In both analyses, the Fisher's LSD multiple comparisons test was used to reveal if significant differences existed between individual sites.

Habitat variables were measured at the sites used for biological population monitoring from 2002 through 2010. Habitat units were identified by type according to a modification of the R1/R4 Habitat Inventory procedures used by the U.S. Forest Service (Overton et al. 1997). The lengths, widths, depths, and substrate characteristics for each habitat unit were measured, and a subjective habitat quality rating, ranging from 0 (degraded) to 5 (optimal) was assessed.

Some habitat metrics such as widths and depths varied little among sites and annually, thus these metrics were not evaluated in this summary. Instead, metrics that were more variable among sites and/or annually were assessed, including the percentage of pool habitat and percent embeddedness. Percent pool habitat is inversely related to the percentage of run and riffle habitat; thus, only percent pool habitat is presented. Percent embeddedness, percent riffle embeddedness, percent fines by area, and percent fines by grid generally demonstrate redundant trends among sites (CEC 2003, 2005a; GEI 2008, 2009, 2010); thus, only the percent embeddedness metric is discussed here. The habitat quality rating from 2002 through 2010 is also discussed as a measure of overall habitat quality.

4.0 Results and Discussion

4.1 Habitat

The percentage of pool habitat varied substantially among sites and years (Figure 2). The minimum percentage of pool habitat was zero for sites RR-20, LR-1, and LR-8a, and three percent for Site LR-16. Overall, the greatest mean percentage of pool habitat occurred at Site LR-16, followed by RR-20, LR-8a, and LR-1. These data demonstrate the dynamic nature of stream systems as the percentage of pool habitat varied from zero or near zero at each site to between approximately 20 to 30 percent. The changes in percent habitat types are often related to the scour effects of high flows, which are important in maintaining and structuring stream channels.

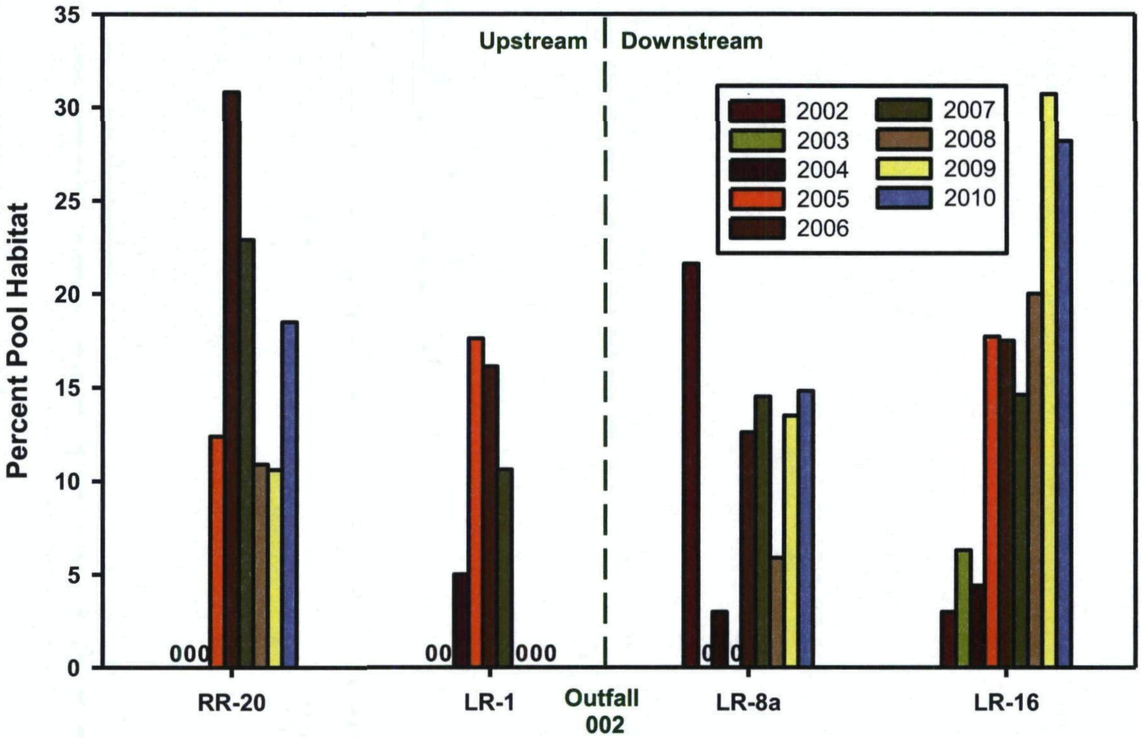


Figure 2: Percent pool habitat for sites on the Red River in the vicinity of Outfall 002 from 2002 through 2010. Zeros represent years with zero percent pool habitat.

Percent embeddedness varied much less among sites than percent pool habitat. Percent embeddedness varied the most among sites in 2002 from a minimum of 16 percent at Site LR-16 to a maximum of 40 percent at Site RR-20 (Figure 3). During the remaining years the difference between the maximum and minimum percent embeddedness was between 2 and 11 percent, indicating that percent embeddedness varied little among sites within years.

In 2007, percent embeddedness was between 60 and 70 percent for each site (Figure 3). The drastic increase in substrate embeddedness was the result of the mudslides from the hydrothermal scar upstream of the Questa Mine on Hot-n-Tot Creek in summer 2007, and the subsequent heavy sediment load into the Red River (GEI 2008, 2009, 2010). High spring runoff flows in 2008 and 2009 gradually flushed out excess sediment, returning embeddedness levels in 2009 and 2010 to levels similar to those observed prior to the mudslides.

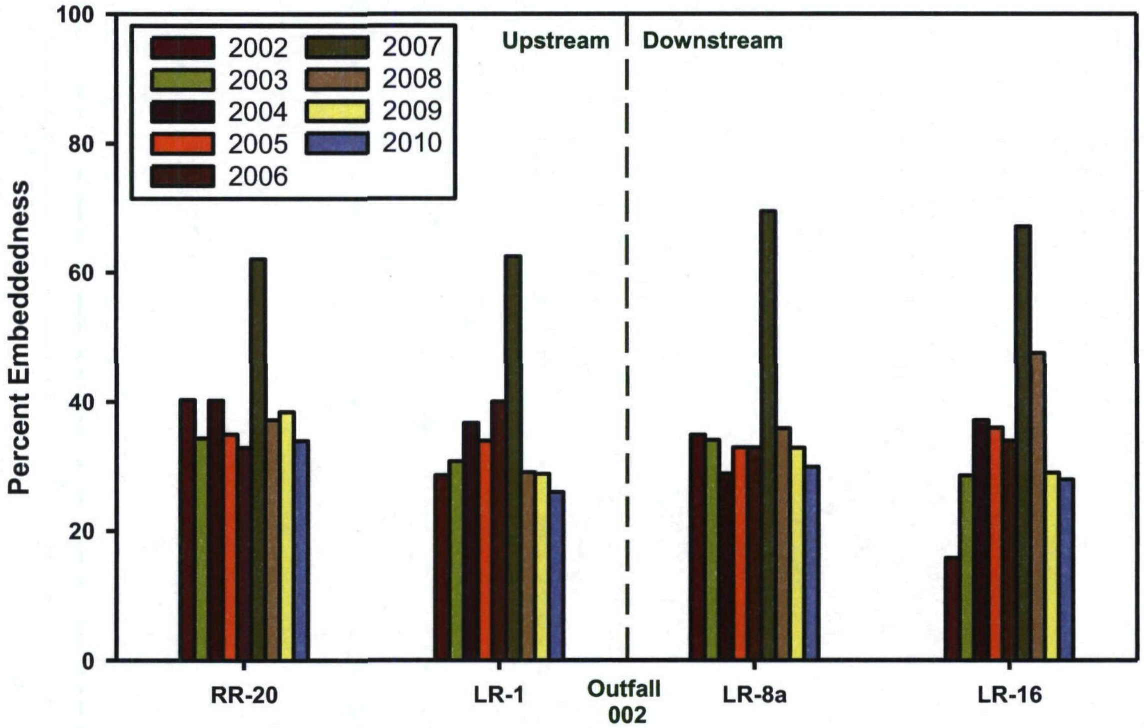


Figure 3: Percent embeddedness for sites on the Red River in the vicinity of Outfall 002 from 2002 through 2010.

Habitat quality ratings varied among sites and years, with the minimum value (2.2) observed at the most upstream site in 2004 and the maximum value (3.9) observed at the most downstream site in 2005 (Figure 4). Overall, the mean habitat quality rating was lowest at the most upstream site (upstream of Outfall 002) and greatest at the most downstream site (downstream of Outfall 002). The sites immediately upstream and downstream of Outfall 002 had the same mean habitat quality ratings (Figure 4). The overall mean habitat quality ratings indicated average habitat conditions at sites RR-20, LR-1, and LR-8a, and slightly above average habitat at Site LR-16.

4.1.1 Summary

Some habitat metrics varied substantially among sites and years, such as the percentage of pool habitat, while others were similar among sites but varied substantially in various years, such as the percent embeddedness. While pool habitat can be important in providing holding water for adult trout, it does not appear to be a limiting factor at sites upstream or downstream of Outfall 002 because in some years resident trout biomass was high when pool habitat was absent. For example, no pool habitat was present at the most downstream site in 2002; however, this site had the highest biomass of the four sites (see discussion below). Run habitat and pocket water behind boulders are also prevalent in this reach, which are also capable of providing holding water for adult trout.

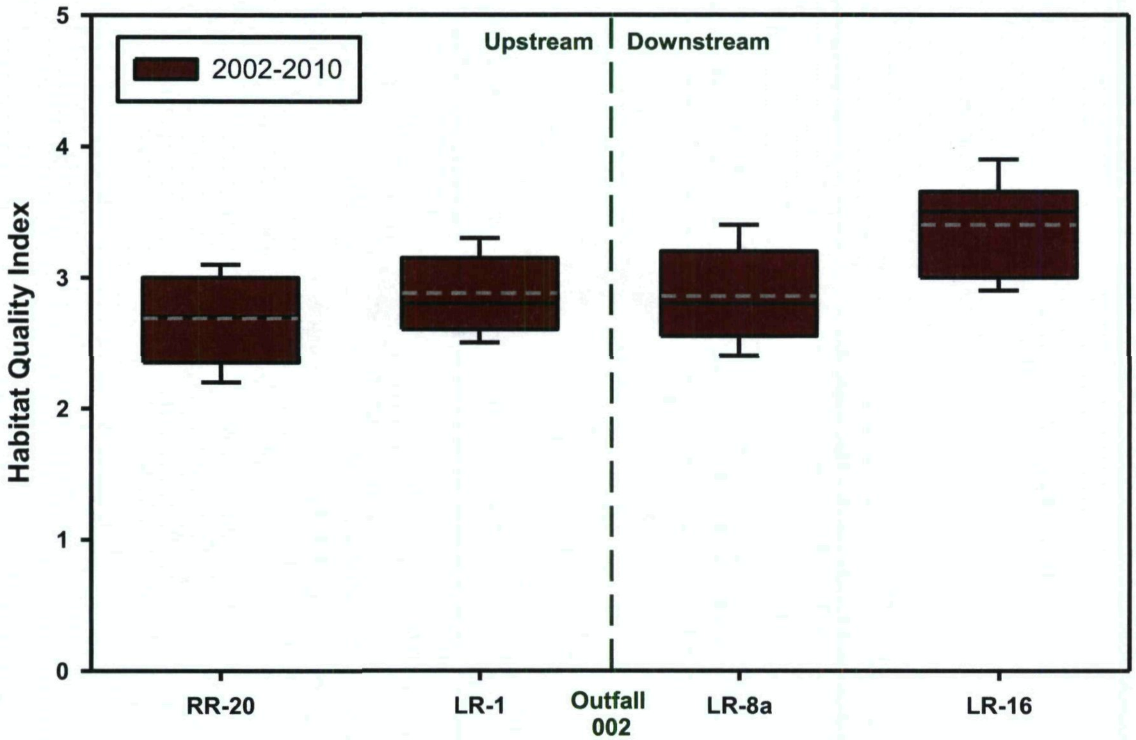


Figure 4: Box plots of the habitat quality index from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

Sedimentation is an important factor determining the distribution of fish (Newcombe and MacDonald 1991; Newcombe and Jensen 1996) and appears to drive fish population dynamics at the two sites both upstream and downstream of Outfall 002 and in reaches further upstream in the Red River in some years. The mass erosion of the hydrothermal scars on Hot-n-Tot Creek, upstream of the mine, in 2007 temporarily degraded water quality and resulted in an increase of stream sedimentation as evident by the high substrate embeddedness observed in 2007. Resident trout density and biomass were lowest in 2007 and 2008 following the mudslides as most of the local resident fish population likely perished or migrated downstream because of the mudslides (GEI 2010). Impacts were evident in the Red River from upstream of the mine and downstream through the study reach, including sites upstream and downstream of Outfall 002. Substrate embeddedness may also influence benthic invertebrate populations, but given the similar substrate embeddedness among the sites upstream and downstream of Outfall 002, it would not likely influence the benthic invertebrate population differentially.

The overall mean habitat quality ratings were equal at the sites immediately upstream and downstream of Outfall 002 indicating similar habitat quality.

4.2 Fish Populations

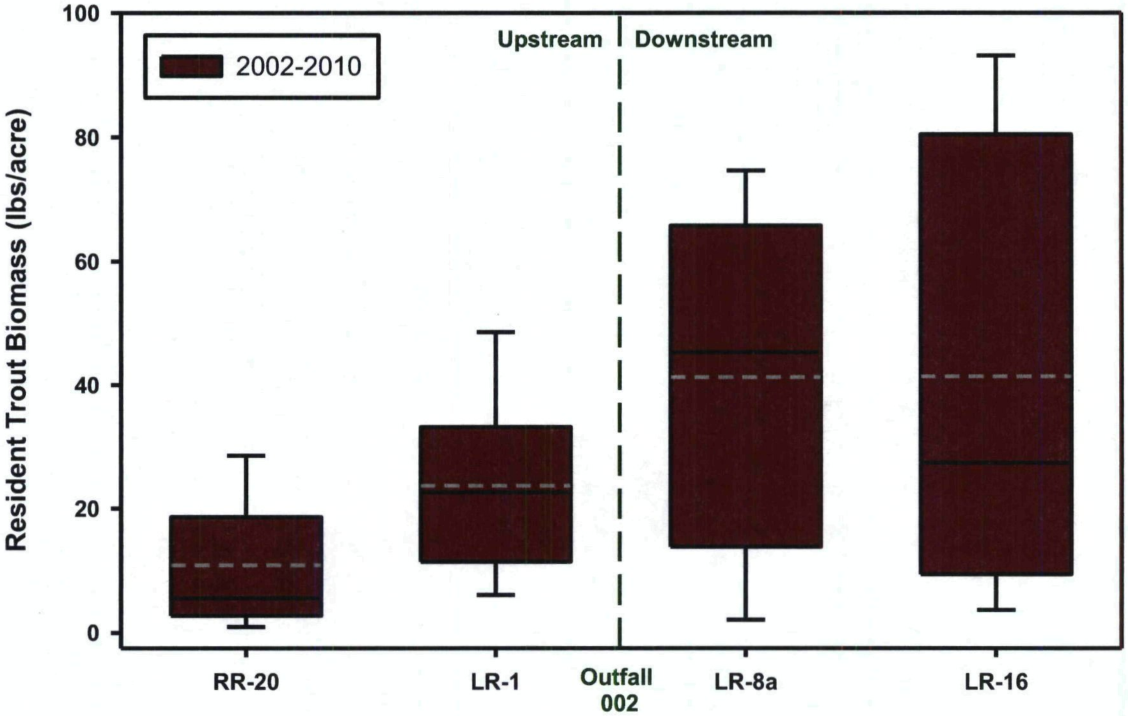
Fish populations have been sampled at two sites upstream and two sites downstream of Outfall 002 from 2002 through 2010. Brown trout have been collected at each site, during each year. Hybrid trout have been collected in 3 of 10 years at each of the two sites upstream of Outfall 002 and in 2 or 4 of the 10 years at the two sites downstream of Outfall 002. Brown trout and hybrid trout are combined and considered resident trout for this evaluation, because both reproduce in the drainage and/or likely reside in the study reach for an extended period of time. When brown trout and hybrid trout were both present, brown trout typically comprised greater than 85 to 90 percent of the resident trout sampled at a site, except in years when total abundance was low. White suckers were also collected in two or three of the years at the upstream sites and one or two of the years at the downstream sites. When white suckers were present, only 1 individual was collected per site; thus, they are not discussed further in this memorandum.

Mean resident trout biomass and density from 2002 through 2010 was lowest at the two sites upstream of Outfall 002 (Figure 5). Mean biomass was greatest at Site LR-8a, the first site downstream of Outfall 002, and mean density was greatest at Site LR-16, the next site downstream (Figure 5). The greatest mean biomass (57.1 lbs/acre) and density (1,268 fish/acre) values for the four sites occurred in 2006 and the lowest mean biomass (5 to 6 lbs/acre) and density (approximately 40 fish/acre) values occurred in 2007 and 2008. The drastic decline in fish biomass and density in this reach is the result of the mudslides from the hydrothermal scar in 2007 on Hot-n-Tot Creek in the upper part of the basin upstream of the mine and well upstream of Outfall 002 and the subsequent heavy sediment load into the Red River described earlier (GEI 2008, 2009, 2010). Fish biomass and density increased gradually from 2007 through 2010 to levels similar to in many of the years prior to the 2007 mudslides (GEI 2008, 2009, 2010; Conklin and Mullen, *in-press*).

Mean biomass and density varied significantly among the four study sites ($p = 0.023$ and 0.027, respectively). Multiple comparisons among sites indicated that the mean biomass at Site RR-20 was significantly less than at the other three remaining sites and mean density at Site RR-20 was significantly less than at the two most downstream sites ($p < 0.05$). The remaining comparisons among sites in mean biomass and density were not significantly different from one another ($p > 0.05$).

4.2.1 Summary

The fish population data from 2002 through 2010 indicate that the overall mean biomass and density was greater at the two sites downstream of Outfall 002 than the two sites upstream of Outfall 002. Furthermore, during individual years, biomass and density were consistently higher at the sites downstream of Outfall 002 than the two sites upstream. These data indicate there were no apparent adverse affects from Outfall 002 on the fish population at the two sites downstream of Outfall 002.



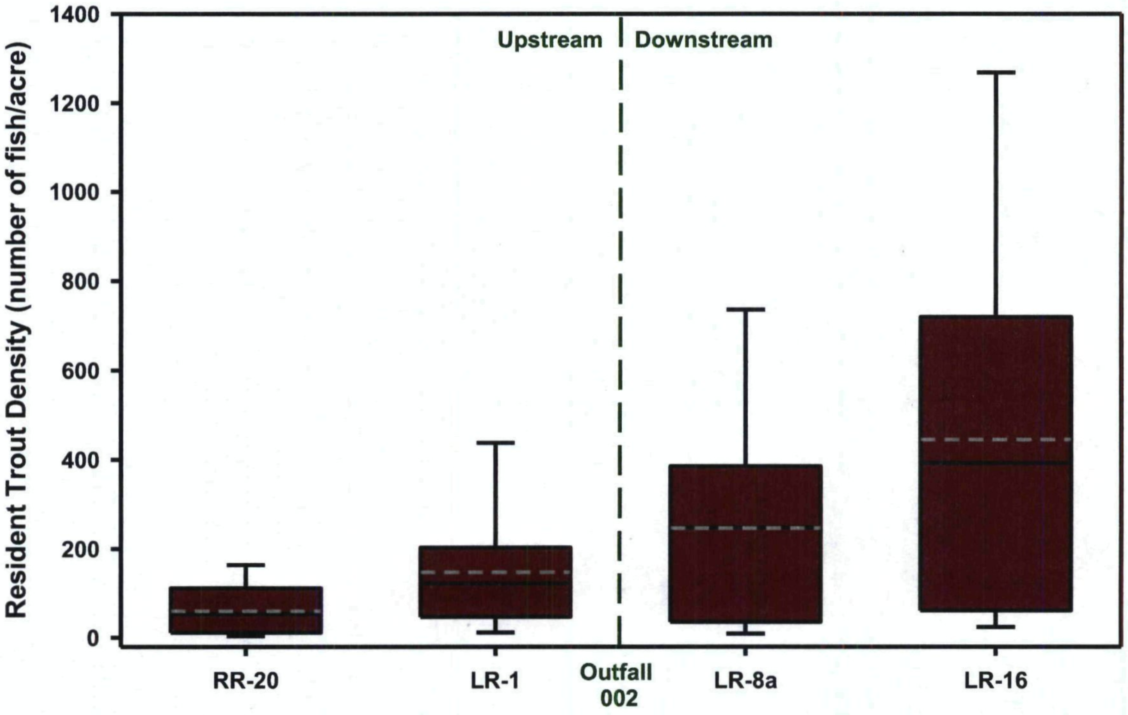


Figure 5: Box plots of the resident trout biomass and density data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

4.3 Benthic Invertebrate Populations

Benthic invertebrate populations have been sampled at two sites upstream and two sites downstream of Outfall 002 from 2002 through 2010. Density has varied substantially among years and among sites from a low of 1,556 individuals/square meter at Site RR-20 to 24,473 individuals/square meter at Site LR-16 (Figure 6). Mean and median densities from 2002 through 2010 were greatest at the two sites downstream of Outfall 002 and lowest at the two sites upstream of Outfall 002 (Figure 6). Density was more variable at the two downstream sites than the two upstream sites.

Mean density varied significantly among sites ($p = 0.003$). Among the individual between-site comparisons, mean densities at the two sites downstream of Outfall 002 were significantly greater than the mean density at Site RR-20 ($p < 0.05$). The remaining comparisons of mean density between sites were not significantly different from one another ($p > 0.05$).

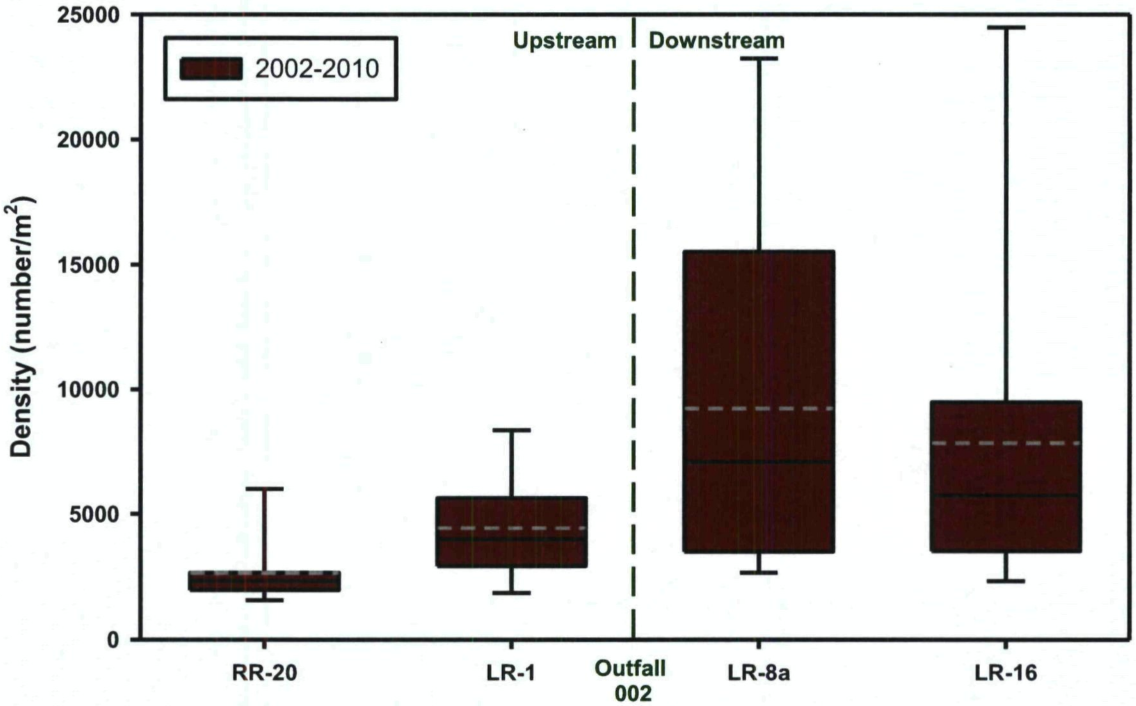


Figure 6: Box plots of benthic invertebrate density data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

Benthic invertebrate number of taxa varied substantially among years and sites, from a minimum value of 27 taxa at Site RR-20 to a maximum value of 46 taxa at Site LR-16 (Figure 7). The mean and median benthic invertebrate numbers of taxa observed from 2002 through 2010 were greater at the two sites downstream of Outfall 002 than at the two sites upstream of Outfall 002 (Figure 7). The variability in the number of taxa was also greatest at the two downstream sites (Figure 7).

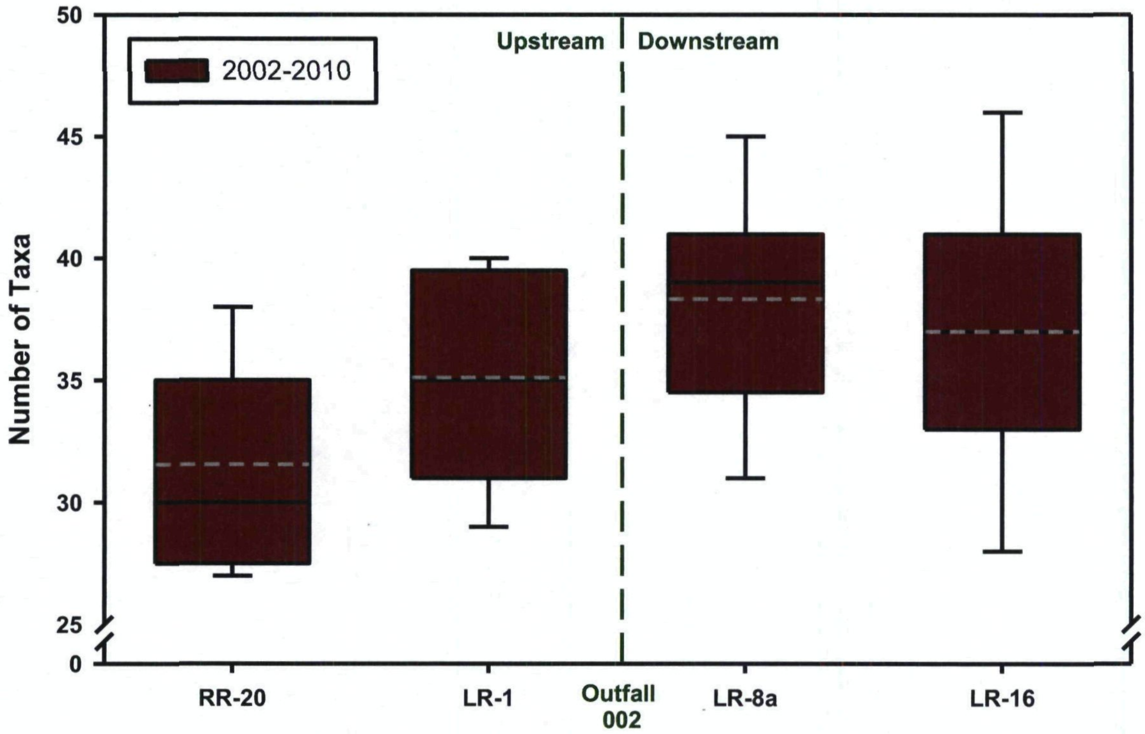


Figure 7: Box plots of number of taxa data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

Mean benthic invertebrate number of taxa from 2002 through 2010 varied significantly among the four sites ($p = 0.022$). The mean benthic invertebrate number of taxa values at the two sites downstream of Outfall 002 were significantly greater than the mean number of taxa at Site RR-20 ($p < 0.05$). The remaining comparisons of mean number of taxa values among individual sites were not significantly different from one another ($p > 0.05$).

Benthic invertebrate number of EPT taxa varied substantially among years and sites, from a minimum value of seven at the most upstream site to maximum of 18 at the most downstream site (Figure 8). The mean number of taxa from 2002 through 2010 was lowest at Site RR-20 (10.9 taxa) and was similar among the other three sites ranging from 12.3 to 13.4 taxa. The variability in the number of EPT taxa was similar among the four sites. There was no significant difference in the mean number of EPT taxa from 2002 through 2010 among sites ($p = 0.235$).

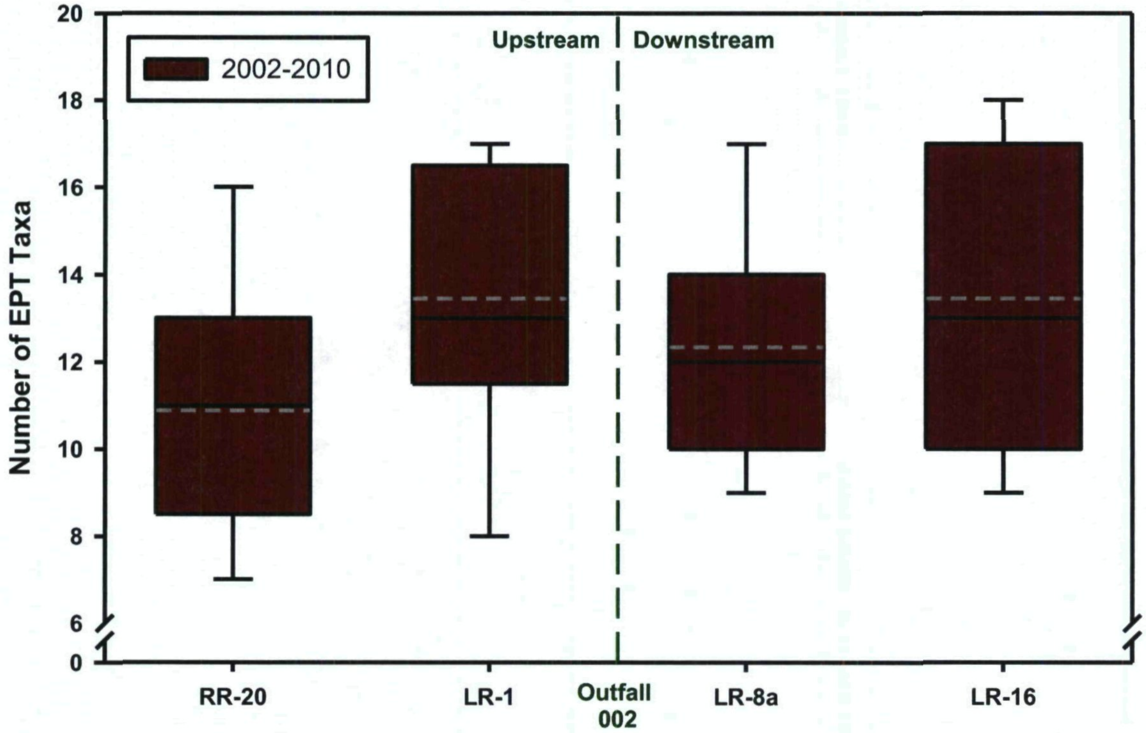


Figure 8: Box plots of number of EPT taxa data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

Mayfly abundance has varied considerably among sites from 2002 through 2010 (Figure 9). The maximum value of 3,347 individuals/square meter was observed at Site LR-1 and the minimum value of 245 individuals/square meter was observed at Site LR-16. The minimum mayfly abundance values were similar among sites and occurred in 2002 for sites LR-1, LR-8a, and LR-16. The overall mean mayfly abundance values among years were lowest in 2002 followed by 2007.

The mean and median mayfly abundance values from 2002 through 2010 were greatest at Site LR-1, smallest at Site RR-20, and similar between sites LR-8a and LR-16 (Figure 9). There was no significant difference in mean mayfly abundance from 2002 through 2010 among sites ($p = 0.434$).

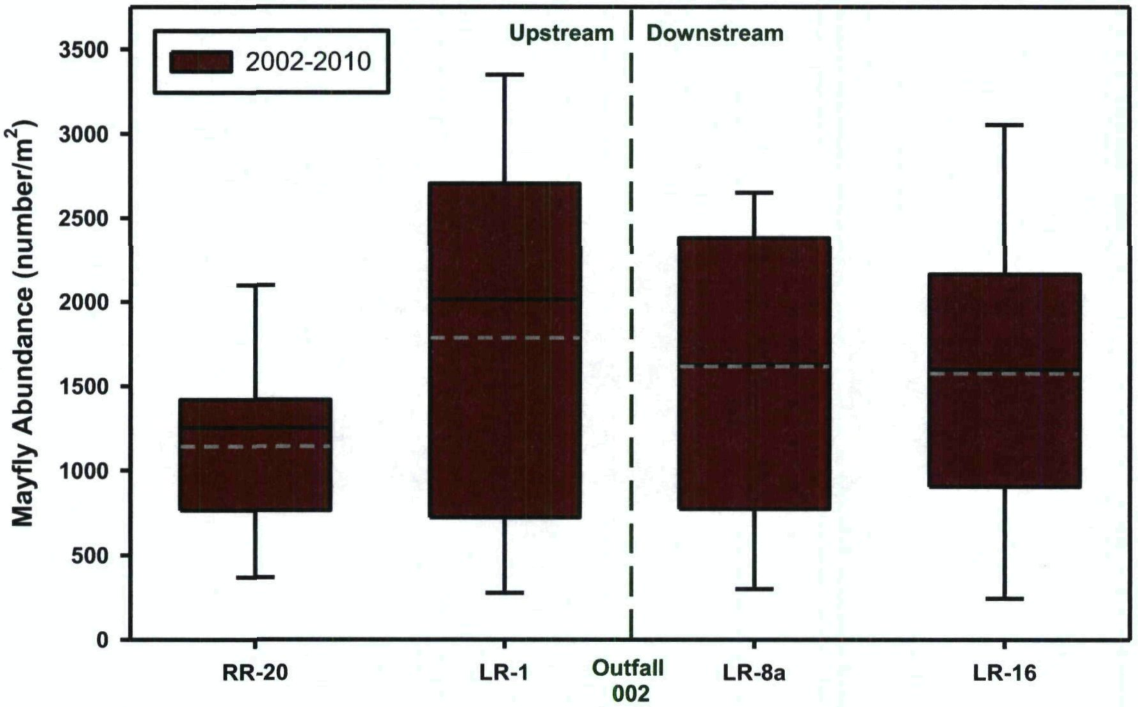


Figure 9: Box plots of mayfly abundance data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

The number of metal intolerant taxa varied less over the monitoring period than the other benthic invertebrate metrics. The minimum number of metal intolerant taxa was zero at Site RR-20 in 2002 and the maximum value was six at Site LR-16 in 2004 and 2010 (Figure 10). The median number of taxa from 2002 through 2010 was three for each site. There were no significant differences in the mean number of metal intolerant taxa among sites ($p = 0.691$).

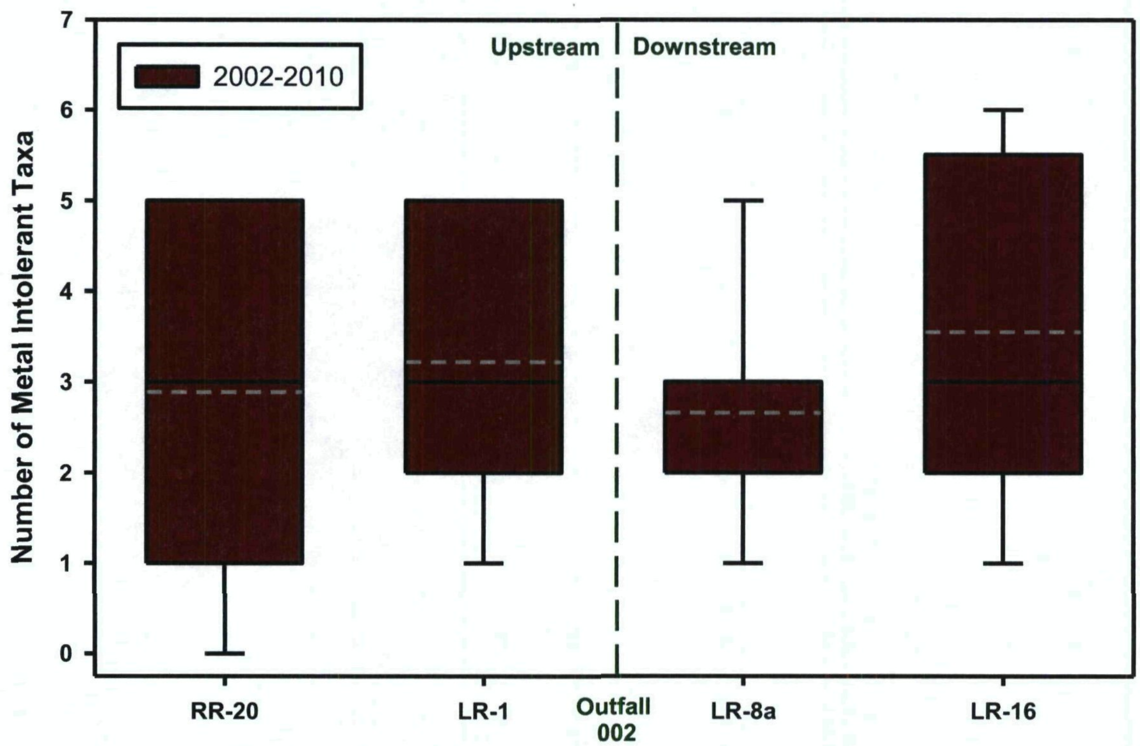


Figure 10: Box plots of number of metal intolerant taxa data from 2002 through 2010 for sites in the vicinity of Outfall 002. The box represents the 25th and 75th percentiles, the whiskers represent the maximum and minimum values, the black line in the box represents the median, and the dotted grey line represents the mean.

4.3.1 Summary

The benthic invertebrate population data from 2002 through 2010 indicate that the overall means for each benthic invertebrate metric was similar to or greater at the two sites downstream of Outfall 002 than the two sites upstream of Outfall 002. Only density and the number of taxa varied significantly and in both cases the only significant between-site comparisons were greater mean density and number of taxa at the two sites downstream of Outfall 002 than the mean values at Site RR-20. These data indicate that there were no apparent adverse affects from Outfall 002 on the benthic invertebrate population at the two sites downstream of Outfall 002.

5.0 Conclusions

Some habitat metrics varied substantially among sites both upstream and downstream of Outfall 002 and among years, such as the percentage of pool habitat, while others were similar among sites but varied substantially between some years, such as the percent embeddedness. While pool habitat can be important in providing cover and habitat for adult trout, it does not appear to be a limiting factor at sites upstream or downstream of Outfall 002 because in some years resident trout biomass was high when pool habitat was absent. Run habitat and pocket water behind boulders are also prevalent in this reach, which are also capable of providing habitat and cover for adult trout.

The mass erosion of the hydrothermal scars upstream of the Questa Mine on Hot-n-Tot Creek in 2007 temporarily degraded water quality and resulted in increased stream sedimentation as evident by the high substrate embeddedness observed in 2007. Resident trout density and biomass were lowest in 2007 and 2008 following the mudslides as most of the local resident fish population likely perished or migrated downstream because of the slides. Impacts were evident in the Red River from upstream of the mine and downstream through the study reach, including sites upstream and downstream of Outfall 002. Substrate embeddedness may also influence benthic invertebrate populations, but given the similar substrate embeddedness among sites upstream and downstream of Outfall 002, it would not likely influence the benthic invertebrate population differentially.

The overall habitat quality ratings were lowest at the most upstream site and greatest at the most downstream site. The overall mean habitat quality ratings were equal at the sites immediately upstream and downstream of Outfall 002 indicating similar habitat quality.

The fish population data from 2002 through 2010 indicate that the overall mean biomass and density was greater at the two sites downstream of Outfall 002 than the two sites upstream of Outfall 002. Furthermore, during individual years, biomass and density were consistently higher at the sites downstream of Outfall 002 than the two sites upstream. These data indicate that there were no apparent adverse affects from Outfall 002 on the fish population at the two sites downstream of Outfall 002.

The benthic invertebrate population data from 2002 through 2010 indicate that the overall means for each benthic invertebrate metric were similar to or greater at the two sites downstream of Outfall 002 than the mean values at the two sites upstream of Outfall 002. Only density and the number of taxa varied significantly and in both cases the only significant between-site comparisons were greater mean density and number of taxa at the two sites downstream of Outfall 002 than the mean values at Site RR-20. These data indicate that there were no apparent adverse affects from Outfall 002 on the benthic invertebrate population at the two sites downstream of Outfall 002.

Overall, aquatic biota population parameters for data from the past 9 years of sampling (2002 through 2010) demonstrated no measurable negative effects when comparing sites upstream and downstream of Outfall 002. Rather, fish population parameters and some benthic invertebrate parameters, such as density and number of taxa, were often greater at sites downstream of Outfall 002 than the upstream sites.

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Geotechnical
Environmental
Water Resources
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Red River Aquatic Biological Monitoring Report, 2010

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Executive Summary

Biological monitoring of the Red River was initiated in 1997 to evaluate the effects of mining operations and mine rock piles on fish and benthic invertebrate populations in the Red River upstream, adjacent to, and downstream of the Questa Molybdenum Mine (Chadwick Ecological Consultants, Inc. [CEC] 1997, 1998). The purpose of this report is to present data on fish populations, fish habitat, and benthic invertebrate populations collected in 2010 in the Red River and to continue to evaluate trends identified in biological parameters and sites monitored since 1997. Long-term trends in fish and invertebrate population parameters are examined to evaluate changes over time that may be the result of mining operations.

The current study area includes the Red River from the Town of Red River downstream to just upstream of the New Mexico Department of Game and Fish (NMDGF) Red River Fish Hatchery. The Chevron Mining Inc. (CMI, formerly Molycorp) Questa Molybdenum Mine is adjacent to the north bank of the Red River in its middle reaches, between the Town of Red River and the Village of Questa. The tailing facility is located west of Questa, and the permitted discharge associated with the tailing facility (Outfall 002) enters the Red River downstream of Questa.

Fish Populations

Resident trout populations from 1997 through 2009 indicated that there were three areas of impact resulting in decreases in trout abundance. These areas are 1) downstream of the Town of Red River, 2) downstream of Hansen Creek, and 3) downstream of Capulin Canyon. The impacted trout populations in these areas are primarily the result of poor water quality and sediment input from hydrothermal scars and upwelling groundwater. Two of these three reaches were identified as areas of impact to the fish populations in the Red River in 2010; however, impacts were not as evident as in the past in the reach immediately downstream of the Town of Red River.

Resident brown trout were collected at all eleven sites in the Red River in 2010. Brown trout were more abundant than hatchery stocked rainbow trout at six of the eleven sites and at all sites combined. Resident trout biomass was relatively high at most sites compared to recent years; however, the biomass at each site was still less than the average biomass of 69 lbs/acre in the Rocky Mountain Forest ecoregion. Young of the year, juvenile, and adult brown trout were collected at all sites, except the Downstream of Hansen and Upstream of Columbine sites, where only juvenile or adults were collected. The presence of multiple age classes of brown trout at most sites, indicates that the Red River supported a more balanced population within the study area in 2010 than in recent years. The low resident trout biomass and density levels, and the lack of or limited number of individuals in some age classes in reaches immediately

upstream of the mine property and near the downstream boundary of the mine property, indicates that the resident trout population continues to appear stressed in these reaches.

Resident trout density and biomass in 2010 was greater than or equal to values observed in 2007, 2008, and 2009 at 10 of the 11 monitoring sites. Although the resident trout population has increased the last few years, the population has not yet completely recovered to levels seen in 2006, prior to the Hot-n-Tot Creek mudslides, as the biomass and density levels in 2010 were less than levels in 2006 at most sites. However, resident trout density and biomass, while less than in 2006, has recovered to levels similar to in many of the years prior to the 2007 mudslides.

Fish population data from three different time-periods of mine operation were assessed and include 1) prior to the initiation of open pit mining, representing baseline data (1960), 2) during the intervening period of open pit and underground mine operation (1974-1988), and 3) present conditions represented by late summer and fall data collected from 1997 through 2010. All three time-periods indicate similar longitudinal trends, with reduced resident trout density reflecting the decreased suitability of the Red River to support trout, first occurring near the Town of Red River. The trends also indicate further impacts to trout downstream of Hansen Creek. Some recovery in trout density occurred in the reach adjacent to the Questa Mine property, but density levels remained low. Trout density decreased again downstream of Capulin Canyon in two of the three time-periods. During all three sampling periods, there was a substantial increase in resident trout density in the reach of the Red River downstream of Cabresto Creek. In this lower reach of the river, trout density returned to levels comparable to or higher than those found in the reach upstream of the Town of Red River.

Habitat

Habitat characteristics were often similar among sites in 2010; however, some longitudinal trends were identified. Depth parameters were similar among most sites, but maximum depths occurred at the Upstream of Hatchery Site. The mean residual pool depth was lowest at the Downstream of Hansen Site, resulting in a decreased quality of refuge areas for fish during low flow and winter conditions compared to the other sites. Habitat quality ratings varied from a low of 2.2 at the Downstream of Hansen Site to a high of 3.4 at the Elephant Rock Site. The low habitat quality rating at the Downstream of Hansen Site was in part related to the low residual pool depths present at this site. Most sites were dominated by riffle habitat in terms of total area, but run habitat was more prevalent at downstream sites. Sediment indices were relatively low at most sites in spring and fall 2010 compared to recent years, with the highest values occurring at the Elephant Rock and Downstream of Hansen Creek sites. The fine sediment and embeddedness metric values in spring and fall 2010 were less than in fall 2006, prior to the 2007 mudslides at most sites. It appears the high flows in 2008, 2009, and 2010 have been sufficient to remove the excess sediment introduced from the summer 2007 mudslides out of the study reach, resulting in substrate characteristics in 2010 that were similar to fall 2006 at most sites.

Substrate embeddedness was highly variable from 2002 through 2010 at the six upstream most sites on the Red River and was generally similar at the downstream sites, except in 2007 when it was high at most sites from the Hot-n-Tot Creek mudslides. A combination of increased sedimentation and decreased water quality from periodic mudslides appears to be a major factor that limits the resident trout population in the Red River over time. Drought and the lack of sizeable spring runoff flows appeared to exacerbate the problem of high sedimentation levels during some years whereas high spring runoff flows following the 2007 mudslides resulted in a substantial reduction in embeddedness levels and substantial recovery in the resident trout population by 2010.

Benthic Invertebrate Populations

The patterns in benthic invertebrate parameters in past years suggest three areas of impact to the Red River, similar to the trends for fish data. The reaches of the river downstream of the Town or Red River, downstream of Hansen Creek, and downstream of Capulin Canyon consistently indicate lower density of invertebrates. All reaches of the Red River support at least some sensitive species of invertebrates during spring and fall sampling, indicating that although sedimentation and/or poor water quality may be affecting the benthic invertebrate population the water quality is sufficient to maintain at least some of the more sensitive species at all sites.

In spring 2010, most metric values at sites adjacent to or downstream of the mine were statistically similar to or greater than mean values at the upstream reference sites. The only exceptions were for number of taxa and density, with the mean number of taxa at the Questa Ranger Station Site significantly lower than the reference site mean and density values significantly lower than the reference site mean at the Downstream of Cabin Springs, Goathill, and Questa Ranger Station sites. These results indicate that the benthic invertebrate communities in spring at sites adjacent to or downstream of the mine were at least as healthy or in many cases healthier than the overall mean upstream reference site.

In fall 2010, the Downstream of Highway 522 and the Upstream of Hatchery sites had mean metric values that were either significantly greater than or not significantly different from the reference site mean values. The remaining sites had at least one mean metric value that was significantly less than the reference site mean values. The percent of EPT taxa, percent density of mayflies, and percent density of heptageniid mayflies were not significantly different or were significantly greater at each of the sites adjacent to or downstream of the mine than the mean metric values for the reference sites. However, the number of metal intolerant taxa metric was significantly less than the reference site mean at the Questa Ranger Station, Upstream of Highway 522, and Downstream of Outfall 002 sites. The Questa Ranger Station Site had a number of metrics that were significantly lower than the reference site mean including density, number of taxa, number of EPT taxa, and number of metal intolerant taxa. Overall, these results indicate that the benthic invertebrate community in fall at sites adjacent to and downstream of the mine was in many cases as healthy as the overall mean upstream reference site, with the exception of the stressed benthic invertebrate community observed at the Questa Ranger Station Site.

In 2010, most metric values in spring were less than in fall. The number of sites where spring values were less than fall for density, total number of taxa, number of EPT taxa, percent EPT taxa, percent density of mayflies, number of metal intolerant taxa, and diversity metrics ranged from seven to nine sites. The percent density of heptageniid mayflies was lower in spring than in fall at 6 of 11 sites. The overall lower metric values in spring than in fall suggest harsh over-winter conditions and improved summer conditions in the Red River.

At all sites along the river, including those in the most impacted reaches, at least some of the more sensitive EPT taxa were present. Heptageniid mayflies, which are especially sensitive to higher metal concentrations, were present at 10 of the 11 sites in spring and all sites in fall 2010. Heptageniid density was lowest at the four upstream most sites, which includes the reference sites in spring and fall. Metal intolerant taxa were detected at all sites in spring and fall, with the fewest metal intolerant taxa present at the Upstream of Highway 522 Site in spring and at the Questa Ranger Station and Downstream of Outfall 002 sites in fall. The presence of metal intolerant taxa at all sites in the Red River indicates that the water quality is suitable to sustain at least some of the more sensitive metal intolerant species at each site.

Trends

Our previous reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010) concluded that the primary impacts to the suitability of the Red River to sustain aquatic biota were occurring just downstream of the Town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon. These three areas all have surface water and/or groundwater connections to the Red River in the area of natural hydrothermal scars. Downstream of the confluence of Cabresto Creek, conditions improved for both fish and benthic invertebrates.

These impacts in the Red River appear to be resulting from the input of excess sediment from a number of sources and decreased water quality, especially at locations receiving drainage from hydrothermal scars. Our previous reports further concluded that baseline data indicated these impacts were present prior to the initiation of open pit mining at the CMI Questa Mine, and in reaches of the Red River upstream of the mine. Overall, the data from 2010 support these conclusions from our previous reports; however, the resident fish community at the June Bug Site did not indicate as much of an impact from the Town of Red River as seen in the recent and historical data. Aquatic biological data from 2010 demonstrate recovery from the 2007 mudslides to levels similar to those observed in many of the recent years since 1997, but not to levels documented in 2006 for fish.

1.0 Introduction

Biological monitoring of the Red River was initiated in 1997 to evaluate the effects of mining operations and mine rock piles on fish and benthic invertebrate populations in the Red River upstream, adjacent to, and downstream of the Questa Molybdenum Mine (Chadwick Ecological Consultants, Inc. [CEC] 1997, 1998). Our original report discussed the approach and scope of the evaluation in detail (CEC 1997). That discussion is not repeated here.

The biological monitoring program for fall of 2002 and spring and fall of 2003 was modified as the result of Chevron Mining Inc. (CMI; formerly Molycorp) entering into an Administrative Order of Consent (AOC) with the U.S. Environmental Protection Agency (EPA) to initiate the Remedial Investigation (RI) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Specific changes to previous monitoring efforts for these years were reported previously (CEC 2003, 2005a) and generally included the addition of several monitoring sites, the collection of data on fish, invertebrate, and plant tissues, and extensive water quality measurements. Beginning in 2006, the total number of study sites was reduced to eleven, representing seven sites sampled since 1997 and four sites added during the RI.

The purpose of this report is to present data on fish populations, fish habitat, and benthic invertebrate populations from sampling conducted on April 7-8 and September 27-30, 2010 by GEI (formerly CEC) and to continue to evaluate the trends identified in previous monitoring reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, 2005b; GEI 2006, 2008, 2009, 2010). Additionally, this report updates the current status of the biological and habitat data at sites monitored since 1997, and continues to develop the database for these parameters at study sites added during the RI process.

1.1 Background

The Questa Molybdenum Mine began operations in 1918, using underground mining methods (Schilling 1990; URS 2002). In 1965, the mine initiated open pit operations that continued until 1983 (URS 2002). Since 1983, the mine has continued operating using underground mining methods. Tailings from the mill are piped to tailings impoundments west of the Village of Questa (Figure 1). Overburden from the open pit mining activities was deposited near the open pit on Questa Mine property in areas that drain Spring Gulch, Sulphur Gulch, Goathill Gulch, and Capulin Canyon (Figure 1).

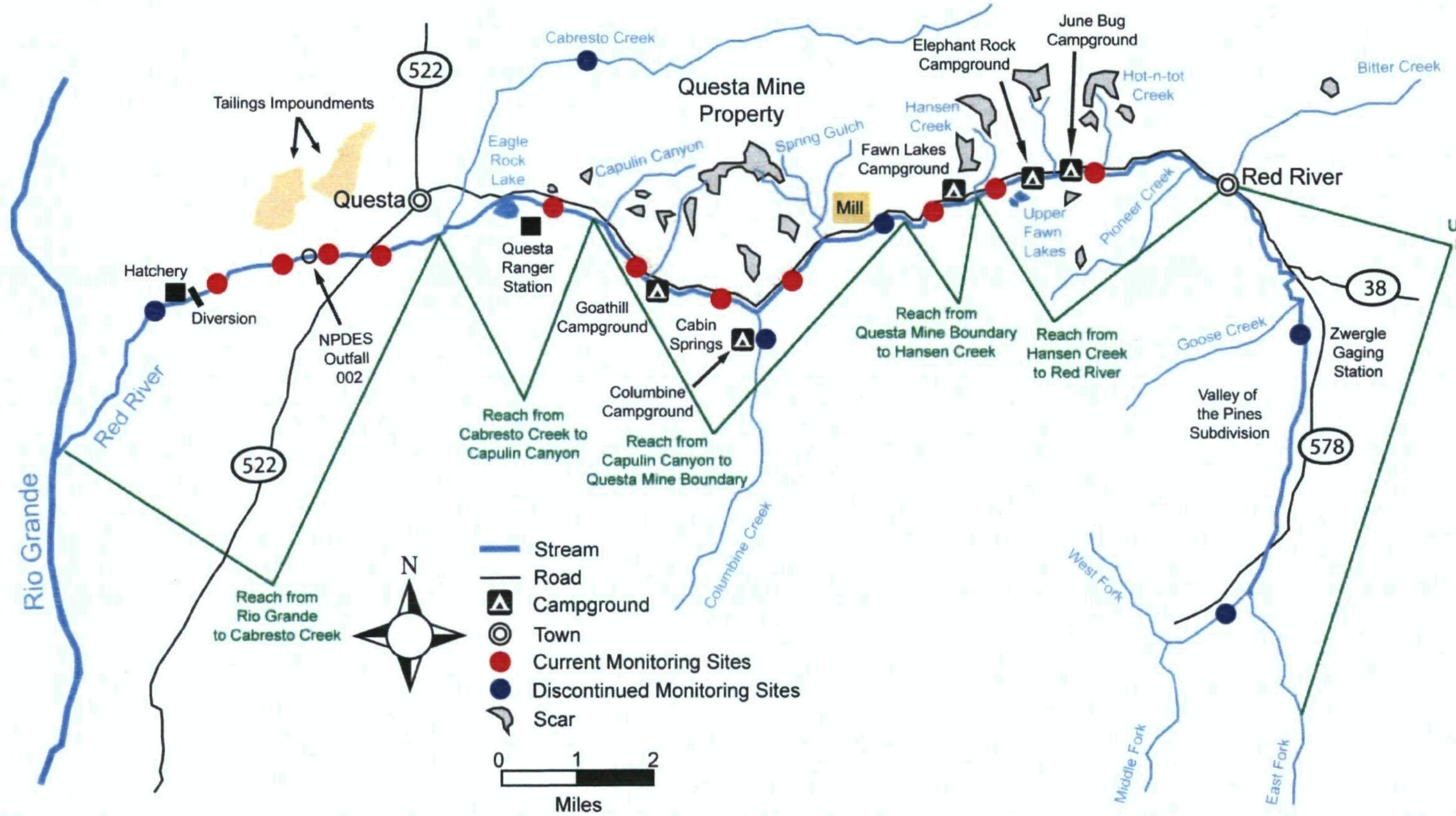


Figure 1: Red River study area depicting six river reaches and current and discontinued monitoring sites.

There are four permitted outfalls through the National Pollution Discharge Elimination System (NPDES) associated with the Questa Mine including Outfalls 001, 002, 004, and 005 (CEC 2005d). Outfall 002 drains the tailings impoundments (Figure 1) and is the only active NPDES permitted outfall in use. Outfall 001 is the outlet from Pope Lake near the tailings impoundments and has not been in use since at least 1993 (Molycorp 1998; CEC 2005d). Outfalls 004 and 005 are part of the stormwater collection system of the mine and have not been historically used for discharge. Stormwater runoff from the mine is collected in ponds, and evaporated off or stored and sent to the tailings ponds (CEC 2005d).

In order to evaluate long-term trends in aquatic biological data, the historical information was divided into three time-periods: 1) baseline (prior to open pit mining), 2) open pit and underground mine operation, and 3) present conditions (CEC 1997). Baseline conditions refer to the period prior to 1966. This includes fish data collected in 1960 by the New Mexico Department of Game and Fish (NMDGF) (1960) and benthic invertebrate data collected in 1965 by the U.S. Department of Health, Education, and Welfare (USDHEW) (1966). During the period of open pit and underground mine operation, benthic invertebrate data were collected from 1970 to 1992, and fish data were collected from 1974 to 1988, by a variety of state and federal agencies and other entities (CEC 1997, 2005c). Present conditions refer to the benthic invertebrate data collected from 1997 through 2010 by GEI and in December 1995 by New Mexico Environment Department (NMED) and CMI (Woodward-Clyde 1996). Present conditions for fish include data collected from 1997 through 2010 by GEI, and data collected in 1997, 1999, 2001 through 2007, and 2009 by NMDGF (1997, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, and 2009). A detailed listing of all available data for baseline conditions, historic conditions in the intervening years of mine operation (data collected 1970-1992), and present conditions (through fall 2008) is contained in previous reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b, c; GEI 2006, 2008, 2009, 2010).

Our initial study (CEC 1997) included an analysis of the historical information from the baseline period and the period of open pit and underground mine operation in addition to the spring 1997 field sampling efforts. The conclusions from the first year of the study (1997) indicated that observed negative impacts to fish and benthic invertebrates in the Red River were caused primarily by naturally occurring hydrothermal scars downstream from the Town of Red River, especially the scar drained by Hansen Creek and the scars in Capulin Canyon.

This pattern was evident during all three time-periods: 1) during baseline conditions prior to open pit mining (pre-1966), 2) during operation of the open pit and underground mine, and 3) during the recent period. The trends indicate the open pit mine and mine rock piles do not measurably impact the suitability of the Red River to support aquatic organisms, given the pre-existing stress from the naturally occurring hydrothermal scars and other impacts.

2.0 Study Area

The current study area includes the Red River from the Town of Red River downstream to just upstream of the NMDGF Red River Fish Hatchery. The Questa Molybdenum Mine is adjacent to the north bank of the Red River in its middle reaches, between the Town of Red River and the Village of Questa (Figure 1).

2.1 Study Sites

The number of study sites has changed over the years with changes in the scope of the project. Monitoring in 1997 and 1998 in the Red River basin consisted of ten monitoring sites on the Red River and selected tributaries (CEC 1997, 1998, and 1999) and in 1999 sampling increased to 12 sites (CEC 2000, 2001, and 2002). With the initiation of RI sampling in 2002, a total of 14 stream sites were selected, nine of which were already established monitoring sites, while five were new sites. Three established monitoring sites were not sampled as part of the RI, but continued to be sampled as part of ongoing monitoring (CEC 2003). The 14 RI sites and three additional monitoring sites were sampled in 2002 and 2003 for the purposes of the RI.

Between 2004 and 2006, after the RI, monitoring was discontinued at some sites because they were not needed to explain the pattern of fish distribution or were redundant with other sites (Figure 1). This mainly included sites upstream of Red River, on tributaries, and downstream of the fish hatchery. Eleven stream sites were incorporated into the monitoring of the Red River (Figure 1) and were sampled in 2006 through 2010. These 11 sites include a combination of seven original monitoring sites and four RI sites added in 2002, as noted below. Three of the sites are upstream of the Questa Mine and serve as reference sites for the eight sites adjacent to and downstream of the mine. Locations for the current monitoring sites are as follows and site abbreviations used throughout the report are in bold.

Red River Sites Upstream of Mine

June Bug Campground **(June Bug)**	This is the first site downstream of Red River and is located near the upstream end of June Bug Campground at an elevation of approximately 8,530 ft. This site is just downstream of Hot-n-Tot Creek and upstream of the Town of Red River's wastewater treatment plant (WWTP).
Downstream of Elephant Rock Campground, upstream of Hansen Creek **(Elephant Rock)**	Located 0.4 mi downstream from Elephant Rock Campground at an elevation of approximately 8,360 ft. This site is downstream of the Red River WWTP and upstream of Hansen Creek.
Downstream of Hansen Creek, upstream of mill **(Downstream of Hansen Creek)**	Located 0.8 mi upstream from the mill access road and 0.7 mi downstream from Hansen Creek at an elevation of approximately 8,140 ft. This site corresponds to the "Bobita Campground" site of the NMDGF and is upstream of the Questa Mine property boundary.

Red River Sites Adjacent to and Downstream of Mine

Downstream of mill, upstream of Columbine Creek **(Upstream of Columbine)**	Located 1.1 mi downstream from the mill access road and upstream of Columbine Creek at an elevation of approximately 8,100 ft. This site is the first site downstream of the Questa Mine property boundary.
Downstream of Cabin Springs and Columbine well field **(Downstream of Cabin Springs)**	Located 0.4 mi downstream of the confluence with Columbine Creek and just downstream of Cabin Springs at an elevation of approximately 7,800 ft. This site was added in fall 2002.
Goathill Campground **(Goathill)**	Located at the upstream end of Goathill Campground at an elevation of approximately 7,670 ft. This site is downstream of Spring 39 but upstream of Spring 13 and Capulin Canyon.
Upstream of Questa Ranger Station **(Questa Ranger Station)**	Located 0.4 mi upstream from the ranger station access road, just upstream from where the tailing pipeline crosses over the Red River. This site is downstream of Capulin Canyon and the area of groundwater upwelling near Spring 13. The elevation of this site is approximately 7,480 ft.
Upstream of Highway 522 **(Upstream of Highway 522)**	Located immediately upstream of the Highway 522 bridge at an elevation of approximately 7,260 ft. This site is downstream of Cabresto Creek in Questa. This site was added in fall 2002.
Downstream of Highway 522 and Questa WWTP **(Downstream of Highway 522)**	Located 0.4 mi downstream of the Highway 522 bridge and just downstream of the Questa WWTP at an elevation of 7,240 ft. This site was added in fall 2002.
Downstream of NPDES Outfall 002 **(Downstream of Outfall 002)**	Located 0.6 mi downstream of the Highway 522 bridge and 0.2 mi downstream of the NPDES Outfall 002 at an elevation of approximately 7,220 ft. This site was added in fall 2002.
Upstream of hatchery diversion **(Upstream of Hatchery)**	Located 0.3 mi upstream of the Red River fish hatchery diversion at an elevation of approximately 7,120 ft.

2.2 Historical and Current Reach Descriptions

In order to organize the available historical fish and benthic invertebrate data in our initial monitoring report (CEC 1997), the Red River was segmented into six reaches (Figure 1). These reaches were used to group data from multiple historical sampling sites into distinct, biologically significant parts of the river, which contain roughly similar characteristics of channel morphology, habitat, potential impacts, etc. This allowed a more focused interpretation of the historical data. These same six reaches are also used to organize the monitoring data collected during 1997 through 2010 in the comparisons to the historical data. Summarized descriptions of the six reaches and the current GEI monitoring sites in each reach are presented below. More detailed descriptions were presented in our previous report (CEC 1997).

2.2.1 Upstream of Red River

This reach of the Red River includes its headwaters downstream to just upstream of the Town of Red River. There is residential development in this portion of the river, primarily in the form of vacation homes and commercial lodges, but not to the extent present in the Town of Red River. The substrate in this reach exhibits little accumulation of silt and sand, with low embeddedness. GEI no longer samples this reach, but NMDGF samples fish at one site upstream of Red River.

2.2.2 Red River to Hansen Creek

This reach extends from the Town of Red River to just upstream of the confluence with Hansen Creek. Bitter Creek flows into the Red River in the Town of Red River. Bitter Creek and other drainages contain historical mining operations and natural hydrothermal scars, which contribute sediment and degrade water quality to the Red River. Impacts to this reach include channelization, erosion from the highway, outfall of the Town of Red River's wastewater treatment facility, and runoff from natural hydrothermal scars drained by Bitter Creek, Straight Creek, and Hot-n-Tot Creek. There are two current GEI monitoring sites in this reach; June Bug and Elephant Rock.

2.2.3 Hansen Creek to Questa Mine Boundary

This reach extends from the confluence with Hansen Creek downstream to the eastern edge of the Questa Mine property boundary. The major characteristic of this reach is the inflow of Hansen Creek, which drains a large area of hydrothermal scarring. Runoff from this scar carries sediment into the Red River, creating a relatively large alluvial fan. Hansen Spring also introduces degraded groundwater to the Red River in this reach. The current GEI monitoring site Downstream of Hansen Creek is in this reach. NMDGF also samples fish at a site near the GEI monitoring site.

2.2.4 Questa Mine Boundary to Capulin Canyon

Extending from the eastern Questa Mine property boundary downstream to just upstream of Capulin Canyon, this reach contains the confluence with Columbine Creek, which joins the Red River from the south side of the valley. Columbine Creek is a small, clear stream with good water quality and low sediment load that adds diluting flows to the Red River, and is the largest tributary in the middle reaches of the Red River. Several areas of upwelling groundwater contribute poor quality water in this reach as well, namely Spring 39 and Cabin Springs. There are three current GEI monitoring sites in this reach adjacent to the mine: Upstream of Columbine, Downstream of Cabin Springs, and Goathill.

2.2.5 Capulin Canyon to Cabresto Creek

This reach extends from the confluence with Capulin Canyon downstream to just upstream of the confluence with Cabresto Creek, in Questa. As with the reach from Hansen Creek to the Questa Mine eastern property boundary, a major feature in this reach is natural hydrothermal scars in Capulin Canyon. Although Capulin Canyon no longer drains directly to the Red River, near the mouth of Capulin Canyon is Spring 13 and an area of upwelling groundwater. The Questa Ranger Station Site is the single GEI monitoring site in this reach. NMDGF also samples fish at a site near the GEI site.

2.2.6 Cabresto Creek to Rio Grande

This reach extends from the confluence with Cabresto Creek, near the Vilage of Questa, downstream to the confluence of the Red River and the Rio Grande. At the upstream end of this reach, Cabresto Creek adds clear, high quality water with low sediment load to the Red River during parts of the year when it is not diverted for irrigation. The river valley widens at Questa, and portions of this reach through Questa have areas of unstable stream banks. The river widens and results in more shallow average water depths compared to downstream portions of this reach. The river valley and stream channel subsequently narrow again upstream of the state fish hatchery and the canyon remains narrow down to the Rio Grande. Outfall 002 drains the tailings impoundments in this reach and discharges into the Red River downstream of Questa and upstream of the canyon. There are four GEI monitoring sites in this reach: Upstream of Highway 522, Downstream of Highway 522, Downstream of Outfall 002, and Upstream of Hatchery. NMDGF also samples fish at one site upstream of the hatchery and one site downstream of the hatchery.

3.0 Methods

3.1 Fish Populations

Fish populations were quantitatively sampled at all 11 monitoring sites in fall 2010, using similar methods as those used in 1997 through 2009. The section of stream sampled at each site was chosen to be representative of the habitat present in that reach of stream, in terms of pool/riffle ratio, shading, bank stability, etc. Sites were of sufficient length to ensure a representative section of the available habitat features and ranged in length from 290 to 450 ft in length. Block nets or natural barriers to fish migration, such as waterfalls, were at the upstream and downstream ends of the sites to minimize movements of fish into or out of the sites during sampling.

Sampling was conducted by making two sampling passes through the stream sites using a bank electrofishing unit consisting of a 4,000-watt generator, a Coffelt voltage regulator (VVP-15), and three electrodes. Fish captured from each pass were kept separate to allow estimates of population density of each species using the maximum likelihood estimator in the "MicroFish" program developed by the U.S. Forest Service (USFS) (Van Deventer and Platts 1983, 1989). Capture efficiencies were sufficiently high (greater than approximately 70 percent of the fish in the first pass) at all sites in 2010, such that two passes were considered adequate for estimating population density (Connolly 1996). All fish sampled were identified, counted, measured for length, weighed, and released. This sampling provided species lists, estimates of density (#/mile, #/acre), biomass (lbs/acre), and the size structure of the fish population.

Trout biomass is usually a more useful indicator of the status of the aquatic environment than density, especially for comparisons among years. While density can be skewed by high numbers of small, young-of-the-year (YOY) fish or low numbers of older, larger fish, biomass is often a more stable and useful indicator from year to year (Platts and McHenry 1988). In our earlier reports, trout biomass was not the focus of our evaluation because many of the historic sources reported only fish density data. However, the results of GEI fish sampling from 1997 through 2010, as well as recent results from NMDGF, include biomass data and allow annual comparisons of biomass over a thirteen-year period.

3.2 Habitat

Habitat characteristics were measured in spring and fall 2010 at all 11 monitoring sites. Instream habitat data were collected concurrently with the macroinvertebrate and fish population sampling.

Habitat evaluations were made using a set of parameters developed and agreed upon for the RI by CEC and representatives of the EPA, U.S. Fish and Wildlife Service, and NMED.

The approach to habitat evaluation is based on the *RI/R4 Fish and Habitat Standard Inventory Procedures Handbook* developed by the USFS (Overton et al. 1997). Individual habitat units were identified using the classification in Overton et al. (1997). Measurements within each habitat unit included length, wetted width, maximum depth, residual pool depth, average depth, habitat quality rating, percent fines by area (visual estimation), percent fines by grid, and embeddedness.

Habitat variables generally fell into one of three categories, 1) sedimentation, 2) unit size, and 3) depth. The first category measures sedimentation and includes embeddedness, percent fines (particles < 4 mm) by area, and percent fines measured by grid. Embeddedness refers to the percentage of larger substrates buried by fine sediments (MacDonald et al. 1991). Embeddedness of riffles was calculated separately due to the importance of these habitat types in fish spawning and macroinvertebrate production. Embeddedness metrics and percent fines by area were calculated for each site by using an area weighted average of the values from each habitat unit. Percent fines by area is a visual estimation of the percentage of the surface area of bottom substrate that is comprised of fine sediments in the entire habitat unit. Percent fines by grid refers to the percentage of fine sediments in flowing areas of habitat units measured using a 49-intersection grid (Overton et al. 1997). Generally, this method is only used in low gradient riffles and scour pool tail crests (Overton et al. 1997); however, this method was also used in run habitat for habitat monitoring on the Red River. Percent fines by grid is a measure of sedimentation in higher velocity areas and is therefore expected to have lower values than percent fines by area.

The second category includes two variables that describe the "size" of the site or habitat units. These variables include measurements of length and width of the habitat units within a site. These two variables were then used to calculate the area of the individual habitat units.

The third category included the depth variables. These included measurements of both the mean and maximum depth for all habitat units within a site, and the residual pool depth. Residual pool depth refers to the depth of the water that would remain in a pool or run if there was no flow (MacDonald et al. 1991)—that is the pool depth at a stage of zero flow. Residual pool depth is a measure of pool quality, with higher residual pool depth indicating pools of higher quality.

The habitat quality rating is a separate, subjective score ranging from one (very poor) to five (very good). The rating was based on an overall assessment of the ability of the habitat unit to support fish and benthic invertebrates based on a subjective judgment of all of the parameters discussed above. In addition, the rating was also based on such variables as the complexity of depth and velocity combinations, suitable trout cover, and bank stability.

In fall, the full set of habitat variables were measured at each site. In spring, the focus of the habitat measurements was on sediment characteristics and only the sedimentation and unit size variables were measured. The depth and habitat quality parameters were not measured in spring. Data from the various habitat units were summarized by calculating the total number of habitat units within a site, the number of habitat units of specific habitat types, and the percentage of total area of each habitat type.

3.3 Benthic Invertebrate Populations

Benthic macroinvertebrates were sampled in spring and fall 2010 at the 11 stream monitoring locations. Sampling methods were similar to those used in 1995 by NMED and CMI (Woodward-Clyde 1996) and by GEI from 1997 through 2009 (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010), and are briefly described below.

Benthic invertebrates were quantitatively sampled at each stream site by taking five replicate samples from similar riffle habitats. Sampling of riffles is adequate to assess characteristics of entire stream segments in biological monitoring programs (Rabeni et al. 1999). A modified Hess sampler, which encloses 0.086 m^2 and has a net mesh size of 500 µm (Canton and Chadwick 1984), was used to collect the invertebrate samples. Five replicate Hess samples were also collected in 1995 by NMED and CMI (Woodward-Clyde 1996). Five replicates provide a reliable estimate of both density and species composition of stream invertebrate communities (Canton and Chadwick 1988).

Collected organisms were preserved in the field with ethanol and delivered to the GEI laboratory in Denver, Colorado, for analysis. In the lab, organisms were sorted from the debris, identified, and counted. Generally, invertebrate samples are subsampled due to very large numbers of organisms (>300 individuals/sample). Subsampling in 2010 consisted of sorting a minimum of 300 invertebrates from at least 3/10 of the sample, with the remainder of the sample searched for large or rare invertebrates not present in the subsample (Vinson and Hawkins 1996; Carter and Resh 2001). For quality assurance, an experienced technician or taxonomist checked all sorted samples and the results were documented for 10 percent of the samples. These procedures indicated over 96 percent thoroughness for sorting in 2010.

The sorted specimens were identified to the lowest practical taxonomic level (Lenat and Resh 2001), which depended upon the age and condition of each specimen, and enumerated by taxon. Quality assurance for identifications and enumerations (Whittaker 1975; Stribling et al. 2003) were randomly conducted on 10 percent of the samples and indicated at least 99 percent agreement for taxonomic and count accuracy in 2010.

Chironomid larvae and oligochaetes were mounted on glass microscope slides and cleared prior to identification and counting. If the number of chironomids or oligochaetes was excessive (i.e., >30 individuals/sample), they were randomly subsampled prior to mounting such that 10 percent of the total number of chironomids or oligochaetes (minimum of 30 individuals each) was mounted. Identification of chironomids was conducted by Dr. Leonard Ferrington, Jr. of the University of Minnesota and identification of oligochaetes was conducted by GEI.

This analysis provided species lists, estimates of density (#/m^2), and the total number of taxa present at each site. Further analysis included calculation of the Shannon-Weaver Diversity Index (H′), which the EPA recommends as a measure of the effects of stress on invertebrate communities (Klemm et al. 1990). This index generally has values ranging from 0 to 4, with values greater than 2.5 generally indicative of a healthy invertebrate community (Wilhm 1970). Diversity values less than 1.0 indicate a stream community under severe stress (Wilhm 1970; Klemm et al. 1990).

In mountain streams, such as those near the Questa Molybdenum Mine, the presence of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (collectively referred to as the EPT taxa) can be used as an indicator of water quality. These insect groups are considered sensitive to a wide range of pollutants (Plafkin et al. 1989; Wiederholm 1989; Klemm et al. 1990; Lenat and Penrose 1996; Wallace et al. 1996; Barbour et al. 1999; Lydy et al. 2000). Stress to aquatic systems can be evaluated by comparing the number of EPT taxa and the percent of EPT taxa (expressed as the percent of the number of EPT taxa relative to the total number of taxa) between unimpacted and potentially impacted sites. Impacted sites would be expected to have fewer EPT taxa and lower percent EPT taxa compared to unimpacted sites. These two parameters were analyzed in this study.

Mayflies are particularly sensitive to heavy metals (Clements 1991, 1994; Clements et al. 1988) and heptageniid mayflies are considered especially sensitive to metals (Kiffney and Clements 1994; Clements et al. 2002). This has been demonstrated in both descriptive and experimental studies (Clements et al. 2002). The absence of heptageniid mayflies appears to be a way to detect low concentrations of metals; therefore, the percentage of mayflies and the percentage of heptageniid mayflies were both calculated (each expressed as a percentage of the total density).

In addition, a group of insect taxa has been identified as especially intolerant of metals in the Southern Rockies (Fore 2002). These metals-intolerant taxa include the mayfly species *Drunella doddsi*, the heptageniid mayfly genera *Cinygmula*, *Epeorus*, and *Rhithrogena*, the mayfly genus *Paraleptophlebia*, the stonefly genera *Skwala*, *Suwallia*, and *Sweltsa*, the caddisfly genus *Rhyacophila*, and the dipteran genus *Pericoma*. The number of metal intolerant taxa was calculated from the invertebrate data and is expected to decline as metal concentrations in the water increase.

Macroinvertebrate population metrics from the three sites upstream of the Questa Mine boundary (June Bug, Elephant Rock, and Downstream of Hansen Creek) were combined into a single reference site value. Measured values from the remaining individual sites were compared with this reference value using analysis of variance (ANOVA) with the Fisher's least significant difference (LSD) multiple comparison test and/or correlation analysis (Hintze 2004). A level of 95 percent ($\alpha = 0.05$) was used to indicate significance. In order to approximate normality, the invertebrate density data were transformed ($\log_{10}$) prior to analysis (Elliott 1977). The summary data tables in this report present composite mean density values (untransformed). However, for the other parameters analyzed (total number of taxa, number of EPT taxa, percent EPT taxa, and diversity), the summary data tables present the results of pooled numbers from the total of the five replicates at a site. All statistical analyses were conducted using NCSS statistical software (Hintze 2004).

3.4 Evaluation of Recent Trends

Fish and benthic invertebrate population data from fall 1997 through fall 2010 collected by GEI were evaluated to determine recent annual variability in fish populations. Only sites currently sampled were evaluated. The fish population data were evaluated by calculating the mean for two time-periods. The first time-period was 1997 through 2001, which corresponds to years prior to the initiation of the RI. The second time-period was 2002 through 2009, which corresponds to the years after the initiation of the RI and includes additional sampling sites that were added during the RI and are currently being monitored. Both time-periods were then compared to data collected in 2010.

Benthic invertebrate population data were compared using the same time-periods, except that additional data were available from 1995, thus the first time-period was from 1995 through 2001. Fall sampling was conducted each year over the monitoring period, thus fall data were used in the comparisons. Spring data for fish were collected only in 1997 and for benthic invertebrates only since 2000 and were not used in the evaluations.

For both fish and benthic invertebrates, the comparisons primarily include evaluations of spatial and temporal trends in the data. In addition, between-year differences for fish density (#/acre) and biomass (lb/acre) data from fall 1997 through 2010 were analyzed using repeated-measures ANOVA (Maceina et al. 1994; Zar 1999), while a general linear model (GLM) ANOVA was also used to determine whether there were significant between-site differences in fish density or biomass over the study period (1997-2010). In both analyses, the Fisher's LSD multiple comparisons test was used to reveal if significant differences existed between individual years or sites. The spatial and temporal variation in fish density and biomass was depicted graphically with box plots or histograms. Histograms were used when a small sample size precluded making box plots with 10th and 90th percentile whiskers.

Trends in habitat data were evaluated for data collected from 2002 through 2010. Most habitat metrics varied little annually, thus only substrate characteristics were evaluated. The individual substrate metrics generally demonstrate the same trends among sites, thus only the percent embeddedness metric was evaluated. Evaluations focused on annual comparisons of percent embeddedness data as related to flow and mudslides.

Linear regression analyses were performed to evaluate the relationship of embeddedness metrics with fish and invertebrate population metrics. The relationship between all habitat characteristics with fish density and biomass were evaluated using a correlation analysis.

3.5 Evaluation of Historical and Recent Trends

For both fish and benthic invertebrates, the recent monitoring data collected since 1997 for fish and 1995 for invertebrates were compared to historical data to evaluate long-term trends in the aquatic biological communities. The historical data and recent monitoring data were organized into the six longitudinal reaches of the Red River previously described (Figure 1).

Fish population data providing longitudinal patterns of fish density are available from three different time-periods of mine operation. Data from 1960 were collected prior to the initiation of open pit mining, and represent baseline data (NMDGF 1960; CEC 2005c). Data collected during the intervening period of open pit and underground mine operation (1974-1988 data) are also presented (CEC 2005c). Present conditions are represented by fall data collected from 1997 through 2010 by GEI, and by late summer or fall data collected by NMDGF in 1997, 1999, 2001 through 2007, and 2009.

As in past reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010), in order to make the datasets for the three periods comparable, only first-pass electrofishing data were used, since this was the primary sampling method used during the earlier studies. One-pass electrofishing is adequate to determine the species of fish present and a general measure of abundance in streams (Reynolds et al. 2003; Bateman et al. 2005). Since rainbow trout are largely maintained by stocking and thus, are not directly controlled by habitat and water quality conditions as are resident fish, rainbow trout numbers have been omitted from the comparison. Finally, since most of the historic data only present density data, longitudinal comparisons of biomass are not made.

For benthic invertebrates, the data were also divided into three time-periods. Baseline conditions were represented by data collected in 1965 (USDHEW 1966; CEC 2005b), apparently prior to the initiation of open pit mining. Data from the intervening period (1970-1992) represent conditions during open pit and underground mining and are presented in CEC (2005b) and Chadwick et al. (2005). Benthic invertebrate data collected in 1995 through fall 1999 and spring and fall of 2000 through 2010 represent present conditions. Present conditions also included the sites on the Middle Fork, upstream of the Town of Red River, downstream of the hatchery, and RI sites for the years when data were available.

Comparisons were made between periods for density ($\#/m^2$) and number of taxa. Techniques for sampling and analyzing invertebrates have varied between the periods (CEC 2005c), making direct comparisons over time difficult. However, assuming similar techniques were employed within each historical time-period and standardizing densities to number of organisms/m^2, comparisons of the longitudinal trends are reasonable.

4.0 Results and Discussion

4.1 Fish Populations

In 2010, brook trout *Salvelinus fontinalis*, brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, hybrid trout (cutthroat x rainbow), and a white sucker *Catostomus commersonii* were collected from the 11 monitoring sites on the Red River (Table 1). Brown trout and rainbow trout were the most widely distributed species, as brown trout were present at all 11 monitoring sites and rainbow trout were present at 10 of the monitoring sites. Hybrid trout were collected at six of the sites, brook trout were collected at two of the sites, and a white sucker was collected at one site. Brown trout were more abundant than rainbow trout at six of the eleven sites and at all sites combined. When present, hybrid trout, brook trout, and white suckers were present at low densities in 2010 (Table 1). From all sites combined, 272 brown trout, 236 rainbow trout, 21 hybrid trout, 3 brook trout, and 1 white sucker were collected. Rainbow trout densities were highest at the four downstream sites near Questa and the NMDGF hatchery.

The sizes of brown trout collected in 2010 ranged from 39 to 374 mm in length (Appendices A and B). This size range includes YOY, juvenile, and adult fish. All three of these life stages were collected at all sites, except the Downstream of Hansen and Upstream of Columbine sites, where only juvenile or adults were collected. The size range of the population generally increased moving downstream. The presence of multiple age classes of brown trout at most sites indicates that the Red River supported a more balanced population within the study area in 2010 than in recent years.

The sizes of hybrid trout ranged from 35 to 333 mm in length (Appendices A and B). This size range includes YOY, juvenile, and adult fish. The low abundance of hybrid trout in 2010 and the low abundance over the monitoring period, indicates that hybrid trout are not maintaining self-sustaining populations in the study reach of the Red River and probably moved downstream from populations in the river upstream of the Town of Red River and from tributaries. Rio Grande cutthroat trout *O. clarkii virginalis* have been collected infrequently in past years (CEC 2005a, b), suggesting that these fish may have migrated from nearby tributary streams. Cutthroat trout were not collected at any Red River sampling site in 2010.

Table 1: Fish population parameters for study sites on the Red River, fall 2010. BRK = brook trout, BRN = brown trout, HYBRID = cutthroat x rainbow hybrid, RBT = rainbow trout, and WS = white sucker.

Site	Species	# Collected	Density		Biomass lbs/acre
			#/mile	#/acre	
June Bug	BRK	2	33	15	0.6
	BRN	43	721	326	26.8
	HYBRID	5	82	37	<0.1
	RBT	11	180	81	36.7
	Total	**61**	**1,016**	**459**	**64.1**
Elephant Rock	BRK	1	16	6	0.1
	BRN	24	419	163	27.7
	RBT	17	274	106	44.6
	WS	1	16	6	0.1
	Total	**43**	**725**	**281**	**72.5**
Downstream of Hansen	BRN	1	15	7	2.5
	RBT	7	103	51	23.6
	Total	**8**	**118**	**58**	**26.1**
Upstream of Columbine	BRN	4	58	29	6.0
	HYBRID	3	43	21	6.2
	RBT	5	72	36	21.8
	Total	**12**	**173**	**86**	**34.0**
Downstream of Cabin Springs	BRN	19	250	138	22.5
	Total	**19**	**250**	**138**	**22.5**
Goathill	BRN	10	130	55	7.9
	RBT	1	13	5	1.2
	Total	**11**	**143**	**60**	**9.1**
Questa Ranger Station	BRN	12	174	71	15.0
	RBT	5	72	30	19.2
	Total	**17**	**246**	**101**	**34.2**
Upstream of Highway 522	BRN	27	325	144	27.4
	HYBRID	2	24	11	1.1
	RBT	48	578	257	94.5
	Total	**77**	**927**	**412**	**123.0**
Downstream of Highway 522	BRN	31	477	156	21.2
	HYBRID	1	15	5	0.6
	RBT	36	554	181	63.0
	Total	**68**	**1,046**	**342**	**84.8**
Downstream of Outfall 002	BRN	51	612	232	43.5
	HYBRID	4	47	18	3.1
	RBT	67	788	299	137.0
	Total	**122**	**1,447**	**549**	**183.6**
Upstream of Hatchery	BRN	50	945	351	16.0
	HYBRID	6	109	41	4.6
	RBT	39	764	284	185.8
	Total	**95**	**1,818**	**676**	**206.4**

Most of the rainbow trout collected at the sites in the Red River in 2010 were approximately eight inches (203 mm) in length or greater, the size that is routinely stocked by NMDGF (NMDGF unpublished stocking records) and the Town of Red River. Previous sampling by GEI has indicated that rainbow trout in the drainage are maintained by regular stocking by the NMDGF and the Town of Red River (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010). As was true in 1997 through 2009, the rainbow trout collected during sampling in fall 2010 were all stocked fish. In order to minimize the effect of stocked fish on the interpretation of the data, the following discussions are based on trends for resident trout, defined as all trout that are maintained by natural reproduction in the drainage (brown, brook, hybrid, and cutthroat trout), and excludes the stocked rainbow trout.

In 2010, resident trout biomass was relatively high at the two upstream sampling sites on the Red River compared to many of the other sites in the study reach (Figure 2). Resident trout biomass was lowest of all sampling sites at the Downstream of Hansen Site, before increasing at the Upstream of Columbine and Downstream of Cabin Springs sites adjacent to the mine. Resident trout biomass was again lower at the Goathill Site, increased downstream to a maximum at the Downstream of Outfall 002 Site, and declined at the Upstream of Hatchery Site. The resident trout biomass observed at each site was less than the average biomass of 69 lbs/acre in the Rocky Mountain Forest ecoregion (Platts and McHenry 1988), which includes the Red River, NM.

Resident trout density demonstrated a similar trend to resident trout biomass (Figures 2 and 3). Resident trout density was near the highest value observed for all sites at the June Bug Site and then declined downstream to the lowest value for all sites at the Downstream of Hansen Site (Figure 3). Density then increased downstream to the Downstream of Cabin Springs Site, declined to the second lowest value observed at the Goathill Site, and then increased downstream to a maximum value for all sites at the Upstream of Hatchery Site. Density and biomass values were generally highest at the uppermost and lowermost sites in the study area and were lowest at the sites near the upstream and downstream boundaries of the mine property.

Data from 2010 indicate that the Red River supported a self-sustaining resident fish population within the study area. While resident trout biomass was less than the average biomass for its region, YOY, juvenile, and adult brown trout were present at most sites indicating a successfully reproducing population. The low resident trout biomass and density levels, and the lack of or limited number of individuals in some age classes in reaches immediately upstream of the mine property and near the downstream boundary of the mine property, indicates that the resident trout population continues to appear stressed in these reaches.

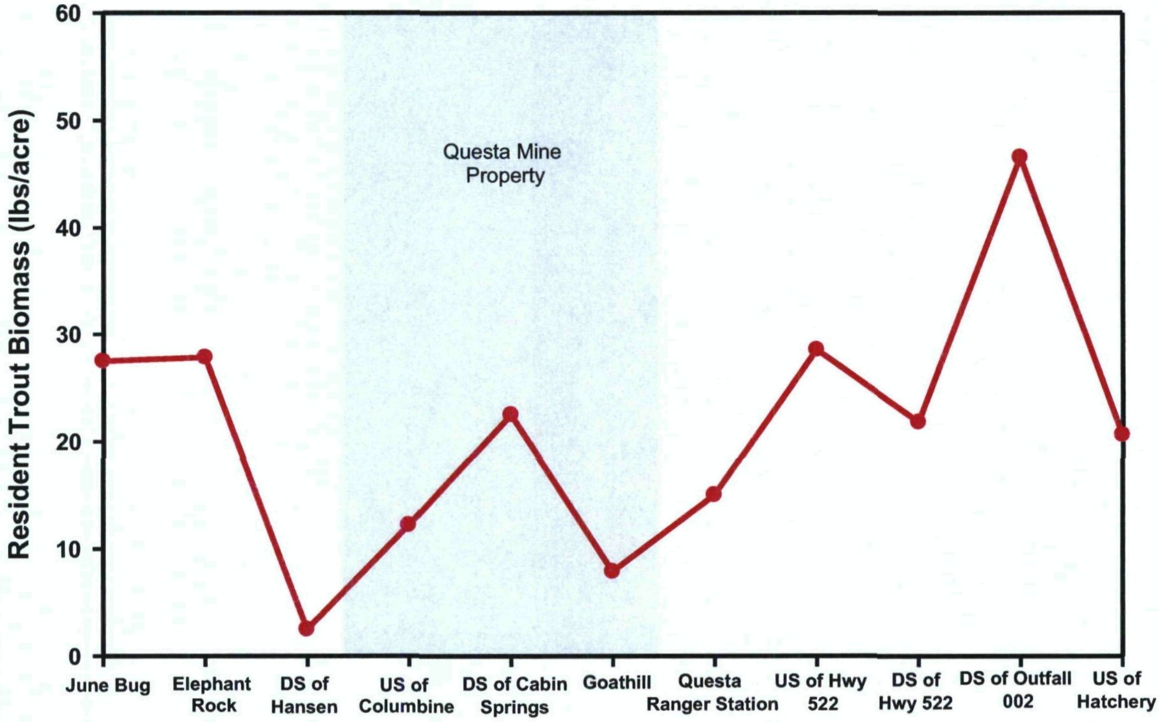


Figure 2: Trend in resident trout biomass (lbs/acre), fall 2010.

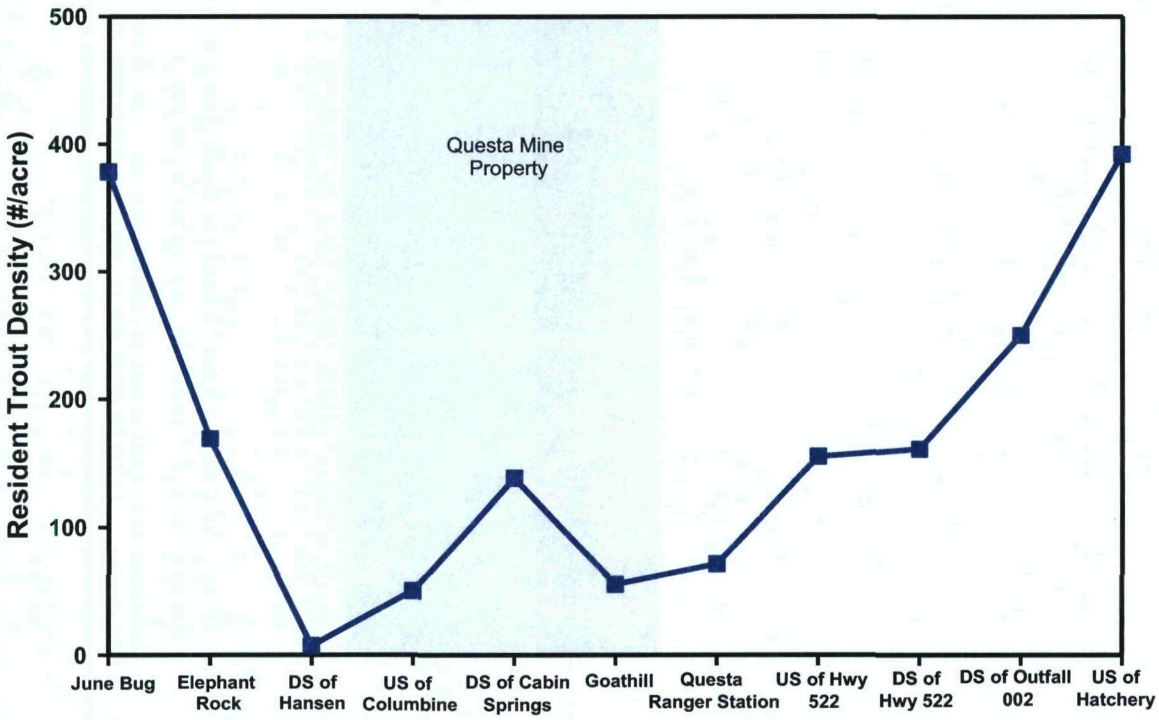


Figure 3: Trend in resident trout density (#/acre), fall 2010.

4.2 Habitat

Heavy rain in late summer of 2007 caused the hydrothermal scar on Hot-n-Tot Creek to slide, resulting in debris flows that were large enough to overflow and block Highway 38 on July 31 and August 1, 2007 (GEI 2008). Subsequent rains in early August caused minor mudslides on other hydrothermal scars downstream of Hot-n-Tot Creek (Jay Gear, Chevron Mining, personal communication). The Hot-n-Tot mudslides introduced sediment to the Red River upstream of the site at June Bug Campground in 2007. Sediment from these slides was a driving factor in the habitat characteristics of Red River monitoring sites in fall 2007, spring and fall 2008, and spring 2009. In fall 2009, much of the remaining sediment from the 2007 mudslides had been moved out of the study reach; however, substrate metric values were still higher at the Elephant Rock Site in fall 2009 than in fall 2006, prior to the slide. In spring and fall 2010, substrate characteristics were similar to in fall 2006 at all sites, indicating that the excess sediment from the Hot-n-Tot Creek mudslides has been removed from the study reach.

The focus of the habitat evaluation in spring 2010 was on sediment indices, thus depth and habitat quality parameters were not evaluated (Table 2). In fall 2010, the complete list of habitat parameters were evaluated. In 2010, habitat complexity was similar between spring and fall, varying by only one or two habitat units at each site (Table 2). The highest number of units measured was at the Downstream of Outfall 002 Site in spring and fall. Five or six habitat units were present at the June Bug, Elephant Rock, Downstream of Hansen, and Downstream of Highway 522 sites, which represented the lowest habitat complexity. Habitat complexity was generally greatest at middle sites and the two downstream most sites in the study area.

Table 2: General habitat characteristics of study sites on the Red River, spring and fall 2010. Depth measurements and habitat quality ratings were determined only in the fall.

Site	# of Habitat Units		Mean Depth (ft)	Mean Max Depth (ft)	Mean Residual Pool Depth (ft)	Mean Habitat Quality Rating
	Spring	Fall				
June Bug	7	5	0.9	1.6	1.0	2.8
Elephant Rock	6	7	0.9	1.5	1.3	3.4
Downstream of Hansen	6	5	1.0	1.4	0.5	2.2
Upstream of Columbine	9	10	1.0	1.6	1.0	2.6
Downstream of Cabin Springs	7	9	1.1	1.8	1.0	3.0
Goathill	7	8	1.0	1.9	1.2	2.9
Questa Ranger Station	9	10	0.8	1.8	1.2	2.8
Upstream of Highway 522	8	9	0.7	1.5	1.0	3.1
Downstream of Highway 522	6	5	0.6	1.4	0.9	2.6
Downstream of Outfall 002	12	11	0.8	1.9	1.4	3.0
Upstream of Hatchery	10	9	1.1	2.1	1.6	2.9

Depth parameters were similar among most sites, but maximum depths occurred at the Upstream of Hatchery Site (Table 2). The mean residual pool depth was lowest at the Downstream of Hansen Site, resulting in a decreased quality of refuge areas for fish during low flow and winter conditions, compared to the other sites.

The mean habitat quality ratings ranged from a low of 2.2 at the Downstream of Hansen Site to a high of 3.4 at the Elephant Rock Site in fall 2010 (Table 2). Overall, habitat quality ratings were average in fall 2010, as only the Downstream of Hansen Site fell outside of the 2.5 to 3.5 range. The habitat quality ratings were similar in 2010 and 2009 and higher than in 2008 at many sites (GEI 2009, 2010), mostly due to less sedimentation in 2009 and 2010.

The dominant habitat type was riffle, followed by run at most sites in 2010 (Figure 4). Run habitat was more prevalent at downstream sites and was the dominant habitat type at the three downstream most sites. Pool habitat comprised greater than 20 percent of the total area at the Elephant Rock, Downstream of Cabin Springs, Goathill, Questa Ranger Station, and Upstream of Hatchery sites. Pool habitat was absent at the June Bug, Downstream of Hansen, and Downstream of Highway 522 sites.

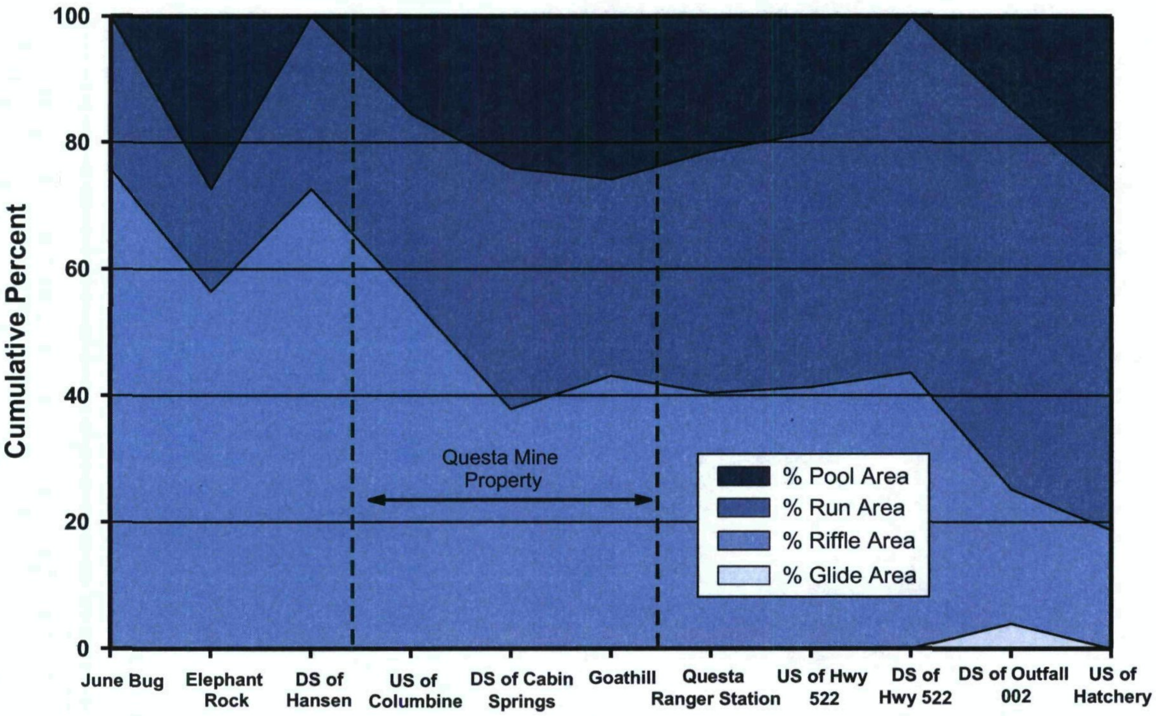


Figure 4: Percentage of habitat types for study sites on the Red River, fall 2010.

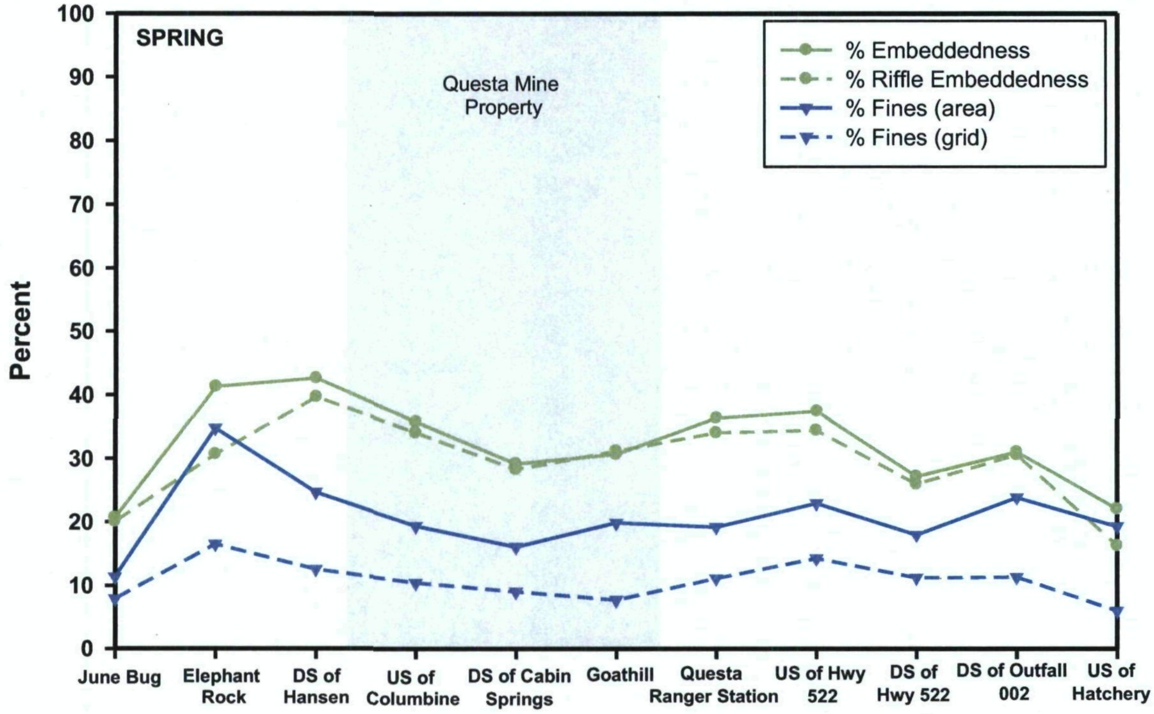
In spring 2010, the percentages of fines by area and by grid were lowest at the upstream most site (Figure 5). Percent fines by area was highest in spring at the Elephant Rock Site and was similar at the remaining sites downstream on the Red River. Percent fines by grid was similar among all sites, varying from only 8 to 16 percent. At the Elephant Rock Site the percent fines by area was higher compared to most sites, while the percent fines by grid remained low, indicating there were areas of sediment deposition in slow moving habitats, such as pools, behind boulders, and along the margins of riffles and runs.

Trends in the percent fines by area and by grid in fall 2010 were similar to trends in spring 2010 (Figure 5). Percentages were lowest in fall 2010 at the uppermost site and the highest values or near the highest values were observed at the Elephant Rock Site. Percent fines by area was similar from the Elephant Rock Site downstream through the study area, while percent fines by grid was similar from the Upstream of Columbine Site downstream through the study area. Percent fines by area and by grid were generally slightly lower in fall than in spring.

In spring 2010, percent embeddedness of riffles and of all habitat units were similar and demonstrate an analogous trend to percent fines metrics (Figure 5). Embeddedness values were among the lowest values observed at the June Bug Site, increased to among the highest values observed at the Elephant Rock and Downstream of Hansen sites, and gradually decreased downstream to the Upstream of Hatchery Site.

Trends in percent embeddedness metrics in fall 2010 followed trends observed in spring and values were similar in magnitude between seasons at most sites. Embeddedness values were among the lowest values observed at the June Bug Site, highest at the Elephant Rock, Downstream of Hansen, and Upstream of Columbine sites, and then decreased at the remaining sites downstream.

The trends in percent fines and embeddedness metrics indicate that much of the excess sediment from the summer 2007 mudslides has been removed from the study area. Some substrate metric values were higher at the Elephant Rock Site than other sites on the Red River; however, these values were mostly related to increased sedimentation in the slower moving pool and run habitats present at this site.



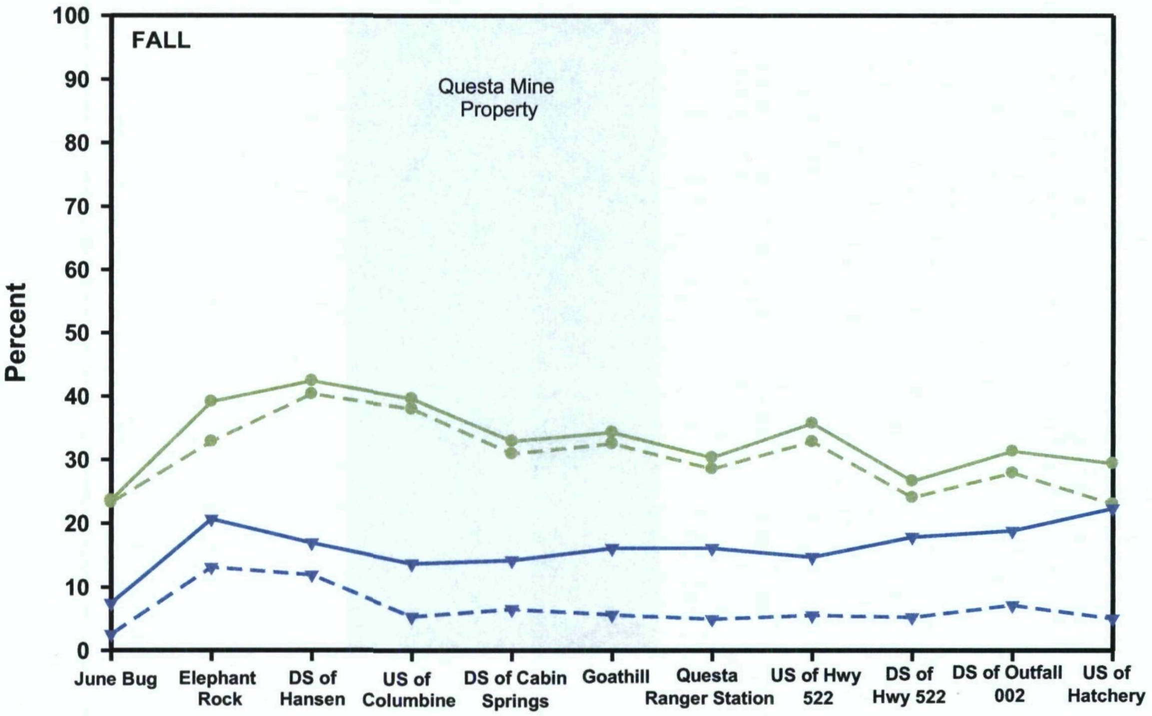


Figure 5: Comparison of percent embeddedness, percent riffle embeddedness, percent fines by area, and percent fines by grid for study sites on the Red River in spring (top) and fall 2010 (bottom).

The amount of fine sediment and the embeddedness in the Red River was substantially less in fall 2009, and spring and fall 2010 than in fall 2007, spring and fall 2008, and spring 2009 at most sites. The fine sediment and embeddedness metric values in spring and fall 2010 were also less than in fall 2006, prior to the 2007 mudslides at most sites (GEI 2008). The maximum daily peak flow recorded for the Red River near Questa was 308 ft^3/s in 2008, 292 ft^3/s in 2009, and 251 ft^3/s in 2010, all of which are similar to or greater than the median peak flow of 245 ft^3/s from 1915 through 2009 (Figure 6; U.S. Geological Survey [USGS] 2010). Apparently, the moderate to high flows in 2008, 2009, and 2010 have been sufficient to remove the excess sediment introduced from the summer 2007 mudslides out of the study reach, resulting in substrate characteristics in fall 2010 that were similar to fall 2006 at most sites.

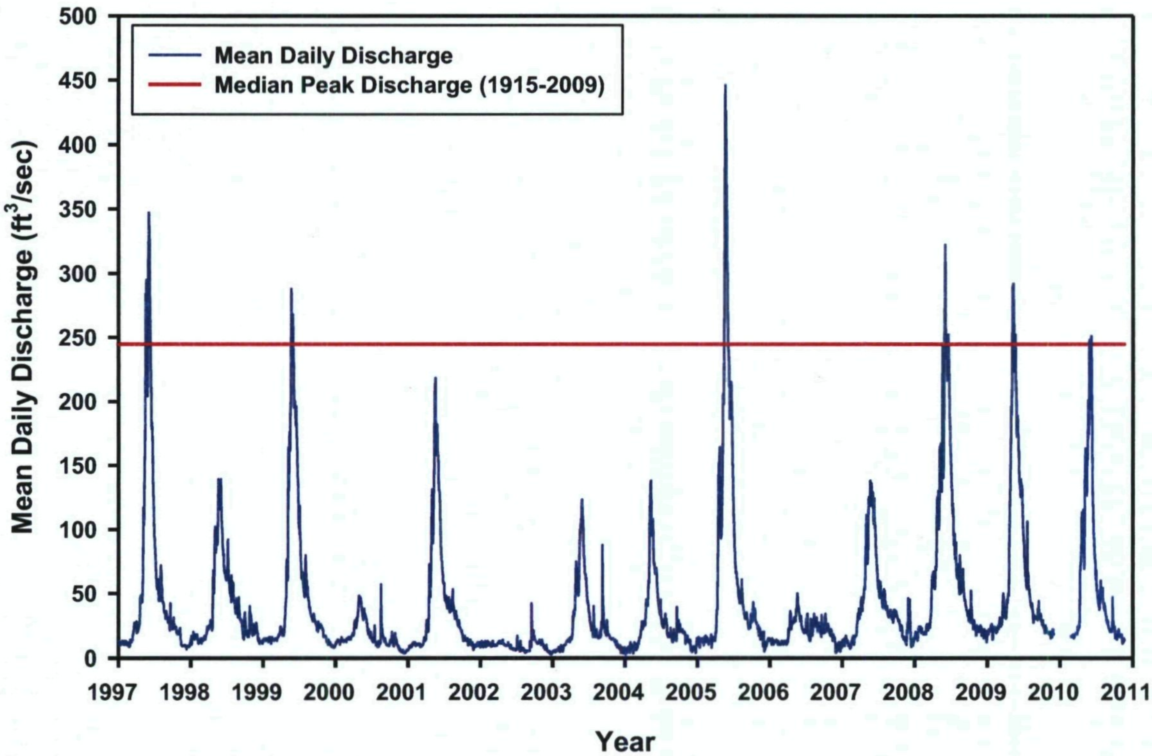


Figure 6: Mean daily discharge (ft^3/sec) and median annual peak discharge of the Red River at USGS Gage 08265000, near Questa, NM.

4.3 Benthic Invertebrate Populations

The June Bug, Elephant Rock, and Downstream of Hansen Creek sites are all located in reaches of the Red River upstream of the Questa Mine property boundary (Figure 1) and are unaffected by mine activities. Therefore, benthic invertebrate population metrics for these three reference sites are used as comparisons to evaluate the relative levels of impact in the Red River. Combining these sites brackets some of the natural spatial variability in invertebrate population metrics and provides an appropriate reference for sites in reaches of the Red River downstream of the Questa Mine property boundary.

4.3.1 Spring 2010

In spring 2010, benthic invertebrate metrics demonstrated variability among the reference sites, in particular between the Downstream of Hansen Site and the two upstream most reference sites. The two upstream sites were similar in many of the benthic invertebrate community metrics, except density was much lower, the percentage of heptageniids was higher, and the number of metal intolerant taxa was lower at the June Bug Site than at the Elephant Rock Site (Table 3, Appendix C). At the Downstream of Hansen Site, values for a number of the metrics were among the lowest observed at all sites, including for the number of taxa, number of EPT taxa, percent density of mayflies, percent density of heptageniid mayflies, and diversity metrics. The diversity index was less than 2.50 at the Downstream of Hansen Site, indicative of a stressed community (Wilhm 1970; Klemm et al. 1990). The percentage of heptageniid mayflies was low at all three reference sites, less than at all the remaining downstream sites; however, the number of metal intolerant taxa ranged from 3 to 5, indicating that some metal intolerant taxa were present at each reference site.

Most metrics were greater at the three sites adjacent to the mine (i.e., Upstream of Columbine, Downstream of Cabin Springs, and Goathill sites) than at the Downstream of Hansen Site, upstream of the mine (Table 3). Density was similar at the three sites adjacent to the mine and less than at the Downstream of Hansen Site and the number of metal intolerant taxa was equal at the Downstream of Hansen and Upstream of Columbine sites. Most metrics increased in a downstream direction within this reach adjacent to the mine, indicating increasingly healthier and more diverse communities progressing downstream.

In the two reaches downstream of the mine, at the Questa Ranger Station Site, values for density, number of taxa, number of EPT taxa, percent density of mayflies, and diversity were among the lowest values from all sites (Table 3). The percentage of EPT taxa was relatively high and the percent density of heptageniid mayflies was similar to values observed at other sites; however, these higher values are likely an artifact of the overall low total number of taxa and density. Metric values for the Upstream of Highway 522 Site were similar to the Questa Ranger Station Site for most metrics, except the percentages of mayflies and heptageniid mayflies were higher, because of the abundance of two mayflies in the genus *Baetis* and the heptageniid mayfly *Rhithrogena hageni*. *Rhithrogena hageni* was the only metal intolerant taxon collected at this site. The benthic invertebrate metrics at the three

Table 3: Benthic invertebrate population parameters for study sites on the Red River, spring 2010.

Site	Density ($\#/m^2$)	Total # of Taxa	# of EPT Taxa	% EPT Taxa	% Density Mayflies	% Density Heptageniids	# Metal Intolerant Taxa	Diversity Index (H')
June Bug	1,753	38	12	32	29	2.5	3	3.43
Elephant Rock	6,767	38	12	32	34	0.0	5	3.42
Downstream of Hansen Creek	5,552	27	10	37	6	<0.1	4	2.27
Upstream of Columbine	2,188	31	12	39	56	5.2	4	2.77
Downstream of Cabin Springs	2,128	39	16	41	51	13.8	5	2.98
Goathill	2,042	40	17	43	51	43.7	6	3.10
Questa Ranger Station	675	26	11	42	18	13.3	4	2.87
Upstream of Highway 522	2,321	28	10	36	72	31.7	1	2.94
Downstream of Highway 522	4,101	48	19	40	59	32.0	5	3.52
Downstream of Outfall 002	12,163	48	20	42	35	10.9	7	3.50
Upstream of Hatchery	5,344	40	18	45	74	18.8	8	3.39

remaining downstream sites were similar among each other and greater for most metrics than at the Upstream of Highway 522 and Questa Ranger Station sites, indicating healthier benthic invertebrate communities.

At each site in the three reaches adjacent to or downstream of the mine, most metrics were statistically similar to ($p > 0.05$) or greater than ($p < 0.05$) mean values at the upstream reference sites (Table 4). The only exceptions were for number of taxa and density, with the mean number of taxa at the Questa Ranger Station Site significantly lower than the reference site mean and density values significantly lower than the reference site mean at the Downstream of Cabin Springs, Goathill, and Questa Ranger Station sites ($p < 0.05$).

EPT taxa metrics, which can reflect changes in water quality, had significantly higher mean values at five or six of the sites adjacent to or downstream of the mine than at the reference sites (Table 4). The significance of specific sites varied by EPT metric and when combined includes at least one of the two metrics at all eight sites. However, the significantly greater percent EPT taxa values at the Questa Ranger Station and Upstream of Highway 522 site than the reference site mean is the product of the low overall total number of taxa. Mayflies and heptageniid mayflies are particularly sensitive to heavy metals pollution. The mean percent density of mayflies was significantly higher at six of the eight sites in reaches adjacent to or downstream of the mine than at the reference sites, and the percent density of heptageniids was significantly higher at seven of the eight sites. The number of metals intolerant taxa metric was significantly higher than the reference value mean at four of the eight sites. These results indicate that the benthic invertebrate communities at sites adjacent to or downstream of the mine were at least as healthy or in many cases healthier than the overall benthic invertebrate community at the upstream reference sites.

Table 4: Statistical significance of benthic invertebrate parameters in relation to combined reference site data for study sites on the Red River adjacent to or downstream of the mine, spring 2010. "+" is significantly greater than the reference value mean, "-" is significantly less than the reference value mean, and "ns" is not significantly different from the reference value mean.

Site	Log_{10} Density	# of Taxa	# EPT Taxa	% EPT Taxa	% Density Mayflies	% Density Heptageniids	# Metals Intolerant Taxa
Upstream of Columbine	ns	ns	ns	+	+	ns	ns
Downstream of Cabin Springs	-	ns	+	+	+	+	ns
Goathill	-	ns	+	+	+	+	+
Questa Ranger Station	-	-	ns	+	ns	+	ns
Upstream of Highway 522	ns	ns	ns	+	+	+	ns
Downstream of Highway 522	ns	+	+	ns	+	+	+
Downstream of Outfall 002	+	+	+	ns	ns	+	+
Upstream of Hatchery	ns	+	+	+	+	+	+

In spring 2010, density and number of taxa metrics demonstrated distinct longitudinal trends with similar trends in number of taxa and number of EPT taxa metrics (Figure 7). Density was lower at the June Bug Site compared to the two other reference sites downstream, the Elephant Rock and Downstream of Hansen sites, which had similar values. Density declined at the three sites in the reach adjacent to the mine and was similar to the June Bug Site. The lowest density value of all sites occurred at the Questa Ranger Station Site, before increasing at the next three sites downstream to a maximum value at the Downstream of Outfall 002 Site, and declining again at the Upstream of Hatchery Site.

The number of taxa and number of EPT taxa were similar at the June Bug and Elephant Rock sites and decreased downstream to the Downstream of Hansen Site (Figure 7). Values for both metrics increased downstream to the Goathill Site, before decreasing to among the lowest values for all sites at the Questa Ranger Station and Upstream of Highway 522 sites. Both metrics increased downstream to among the highest values for all sites at the three downstream most sites.

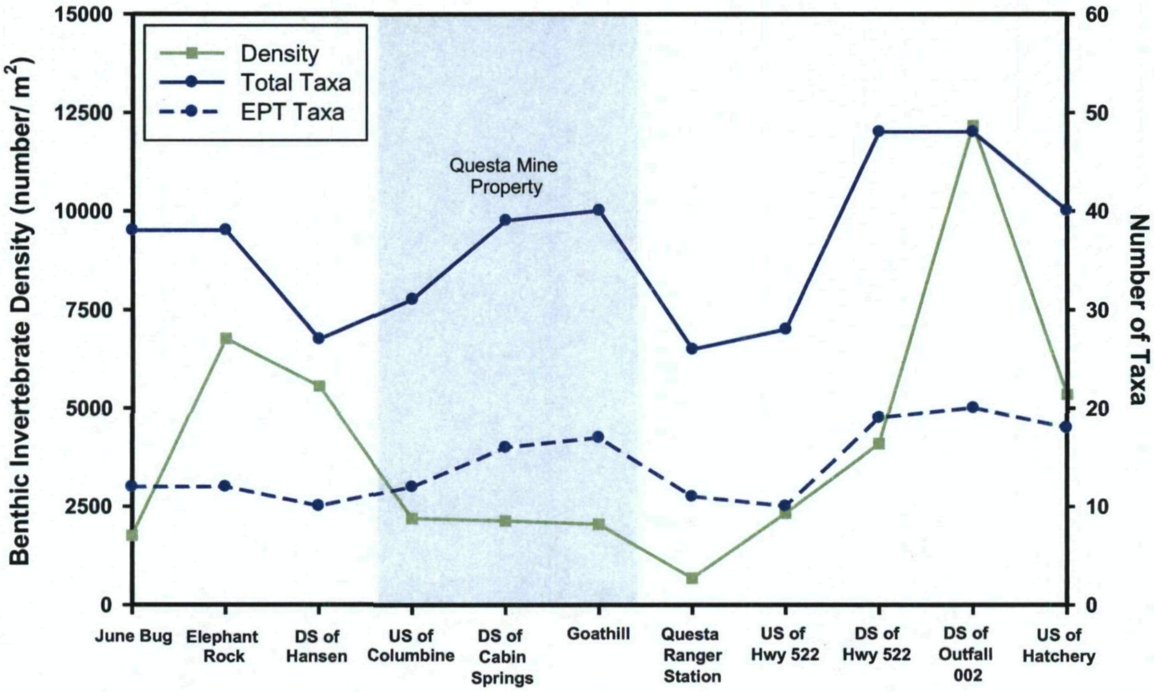


Figure 7: Trends in benthic invertebrate density (#/m^2), total number of taxa, and EPT taxa, spring 2010.

4.3.2 Fall 2010

Most benthic invertebrate parameters were similar among the three reference sites in fall 2010 (Table 5). However, the number of EPT taxa was higher at the June Bug Site than at the two downstream reference sites and density was relatively low at the Downstream of Hansen Site compared to the two upstream most reference sites. Diversity decreased progressively downstream. The remaining metrics were similar among the three reference sites. Values for most metrics in fall 2010 were greater than in spring 2010 (Tables 3 and 5).

Relative comparisons of benthic invertebrate metrics at sites in the reach adjacent to the mine versus sites upstream of the mine, varied depending on the metric (Table 5). Values for the percent EPT taxa, percent density of mayflies, and number of metal intolerant taxa at the three sites adjacent to the mine (Upstream of Columbine, Downstream of Cabin Springs, and Goathill sites) were within the range or greater than values observed at the three upstream reference sites. Density at the Downstream of Cabin Springs Site and the percent density of heptageniid mayflies at the Upstream of Columbine Site were less than the observed range at the reference sites. All three sites adjacent to the mine had lower total number of taxa and diversity values than the upstream reference sites. Despite these lower metrics values at sites adjacent to the mine than sites upstream of the mine, benthic invertebrate communities in these two reaches appear to be in similar health, given the similar or greater number of EPT taxa, percentages of mayflies and heptageniid mayflies, and the number of metal intolerant taxa in the reach adjacent to the mine.

In the reaches downstream of the mine, the numbers of taxa and metal intolerant taxa were less than the range of values observed at the three upstream reference sites at all five and four of the five sites in this reach, respectively (Table 5). The percent density of heptageniid mayflies was substantially higher than the range observed at the reference sites, because of the abundance of one taxon, *R. hageni*, at each site. Values for density, number of taxa, number of EPT taxa, number of metal intolerant taxa, and diversity at the Questa Ranger Station Site were the lowest values observed of all sites. Density was also relatively low at the Upstream of Highway 522 Site, and the numbers of EPT taxa and metal intolerant taxa observed at the Downstream of Outfall 002 Site were the second lowest values observed of all sites.

Table 5: Benthic invertebrate population parameters for study sites on the Red River, fall 2010.

Site	Density (#/m^2)	Total # of Taxa	# of EPT Taxa	% EPT Taxa	% Density Mayflies	% Density Heptageniids	# Metal Intolerant Taxa	Diversity Index (H')
June Bug	5,928	45	22	49	49	3.8	6	3.71
Elephant Rock	7,382	48	16	33	41	4.7	6	3.57
Downstream of Hansen Creek	3,652	43	18	42	56	2.5	6	3.41
Upstream of Columbine	4,810	37	18	49	61	2.2	7	3.23
Downstream of Cabin Springs	3,257	40	18	45	67	10.5	7	3.13
Goathill	4,551	35	17	49	59	18.0	6	3.34
Questa Ranger Station	1,778	21	9	43	57	39.3	2	2.59
Upstream of Highway 522	2,784	38	16	42	48	29.7	5	3.73
Downstream of Highway 522	3,993	38	16	42	60	32.0	5	3.39
Downstream of Outfall 002	5,021	39	13	33	41	16.3	3	3.82
Upstream of Hatchery	4,161	41	18	44	53	26.6	6	3.44

Analysis of variance results indicated that the Downstream of Highway 522 and the Upstream of Hatchery sites had mean metric values that were either significantly greater than ($p < 0.05$) or not significantly different ($p > 0.05$) from the reference site mean values (Table 6). The remaining sites had at least one mean metric value that was significantly less than the reference site mean values. The percent of EPT taxa, percent density of mayflies, and percent density of heptageniid mayflies were not significantly different or were significantly greater at each of the sites adjacent to or downstream of the mine than the mean metric values for the reference sites, indicating these sites were at least as healthy as the upstream reference sites. However, the number of metal intolerant taxa metric was significantly less ($p < 0.05$) than the reference site mean at the Questa Ranger Station, Upstream of Highway 522, and Downstream of Outfall 002 sites.

Table 6: Statistical significance of benthic invertebrate parameters in relation to combined reference site data for study sites on the Red River adjacent to or downstream of the mine, fall 2010. "+" is significantly greater than reference values, "-" is significantly less than reference values and "ns" is not significantly different than reference values.

Site	Log_{10} Density	# of Taxa	# EPT Taxa	% EPT Taxa	% Density Mayflies	% Density Heptageniids	# Metals Intolerant Taxa
Upstream of Columbine	ns	-	ns	ns	+	ns	ns
Downstream of Cabin Springs	-	ns	ns	+	+	ns	ns
Goathill	ns	-	ns	+	ns	+	ns
Questa Ranger Station	-	-	-	+	ns	+	-
Upstream of Highway 522	-	ns	ns	ns	ns	+	-
Downstream of Highway 522	ns	ns	+	+	ns	+	ns
Downstream of Outfall 002	ns	ns	ns	ns	ns	+	-
Upstream of Hatchery	ns	ns	ns	+	ns	+	ns

The Questa Ranger Station Site had a number of metrics that were significantly lower than the reference site mean including density, number of taxa, number of EPT taxa, and number of metal intolerant taxa ($p < 0.05$) (Table 6). This site also had a significantly higher percentage of EPT taxa and density of heptageniids than the reference sites ($p < 0.05$); however the higher percentage of EPT taxa was the product of having a low total number of taxa and the high percentage of heptageniids was the result of one abundant heptageniid mayfly, *R hageni.*

Number of taxa and number of EPT taxa demonstrated similar longitudinal trends at sites along the Red River in fall 2010 (Figure 8). The three highest values for the number of taxa occurred at the upstream references sites and then declined downstream to the lowest value observed at the Questa Ranger Station Site. The number of taxa then increased at the next site downstream and was similar at the remaining downstream sites. Similarly, the number of EPT taxa was highest at the June Bug Site and was similar from the Elephant Rock Site downstream to the Goat Hill Site. The number of EPT taxa then declined to the lowest value observed at the Questa Ranger Station Site and then was similar from the Upstream of Highway 522 Site downstream to the Upstream of Hatchery Site. Density fluctuated among study sites in fall 2010, with the June Bug and Elephant Rock sites exhibiting the highest densities and the Questa Ranger Station and Upstream of Highway 522 sites exhibiting the lowest densities (Figure 8).

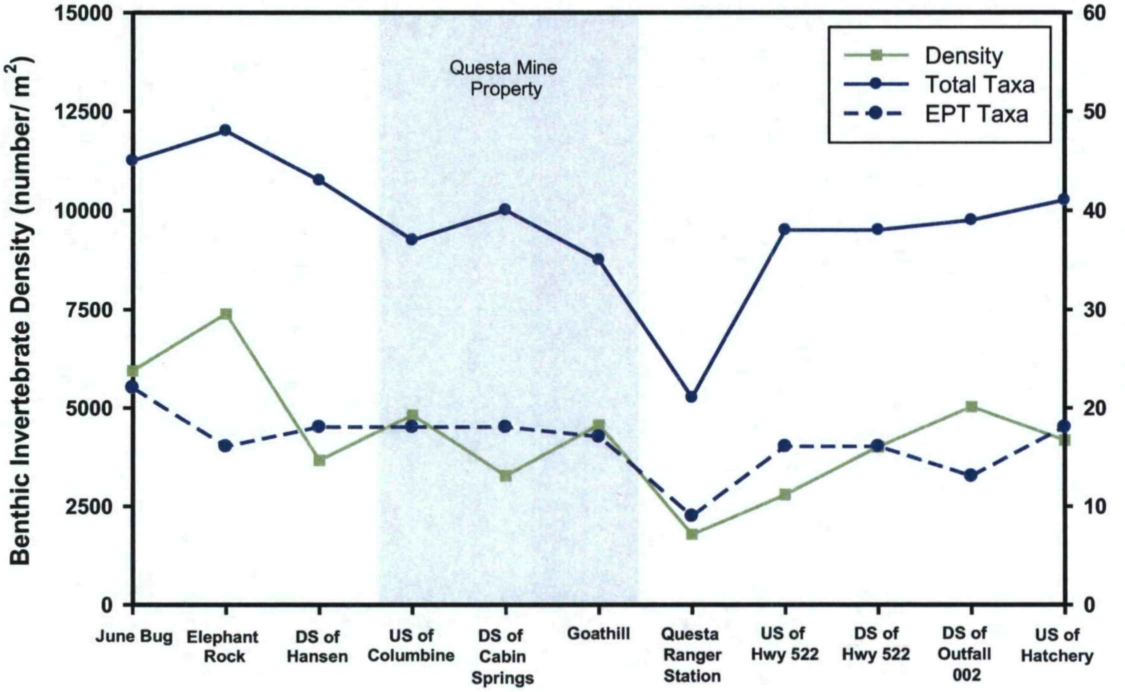


Figure 8: Trends in benthic invertebrate density (#/m2), total number of taxa, and EPT taxa, fall 2010.

In 2010, most metric values in spring were less than in fall (Tables 3 and 5). The number of sites where spring values were less than fall values for density, number of taxa, number of EPT taxa, percent EPT taxa, percent density of mayflies, number of metal intolerant taxa, and diversity ranged from seven to nine sites. The percent density of heptageniid mayflies was lower in spring than in fall at 6 of 11 sites. The overall lower metric values in spring than in fall suggest harsh over-winter conditions and improved summer conditions in the Red River.

The lower number of taxa, percentage of mayflies, and diversity in spring 2010 at the Downstream of Hansen Site compared to the Elephant Rock Site suggests an area of impact to the benthic invertebrate community near the upstream boundary of the mine property. Most of the benthic invertebrate metrics at the Downstream of Hansen Site in fall 2010 were similar to the other Red River study sites, indicating that impacts to the benthic invertebrate community in fall were not evident. Many of the benthic invertebrate metrics were lower and in some cases significantly lower at the Questa Ranger Station Site than at the reference sites in both spring and fall 2010, suggesting the benthic invertebrate community at this site was also stressed. The lower benthic invertebrate metric values near the upstream boundary of the mine property are likely related to the input of poor water quality water and sediment from Hansen Creek. The lower benthic invertebrate metric values at the Questa Ranger Station Site are likely related to the input of poor water quality water from Capulin Canyon and Spring 13 as embeddedness and fine substrate characteristics at this site were similar to other reaches in the study area where benthic invertebrate metrics were higher.

5.0 Recent Trends in Aquatic Biota

5.1 Fish

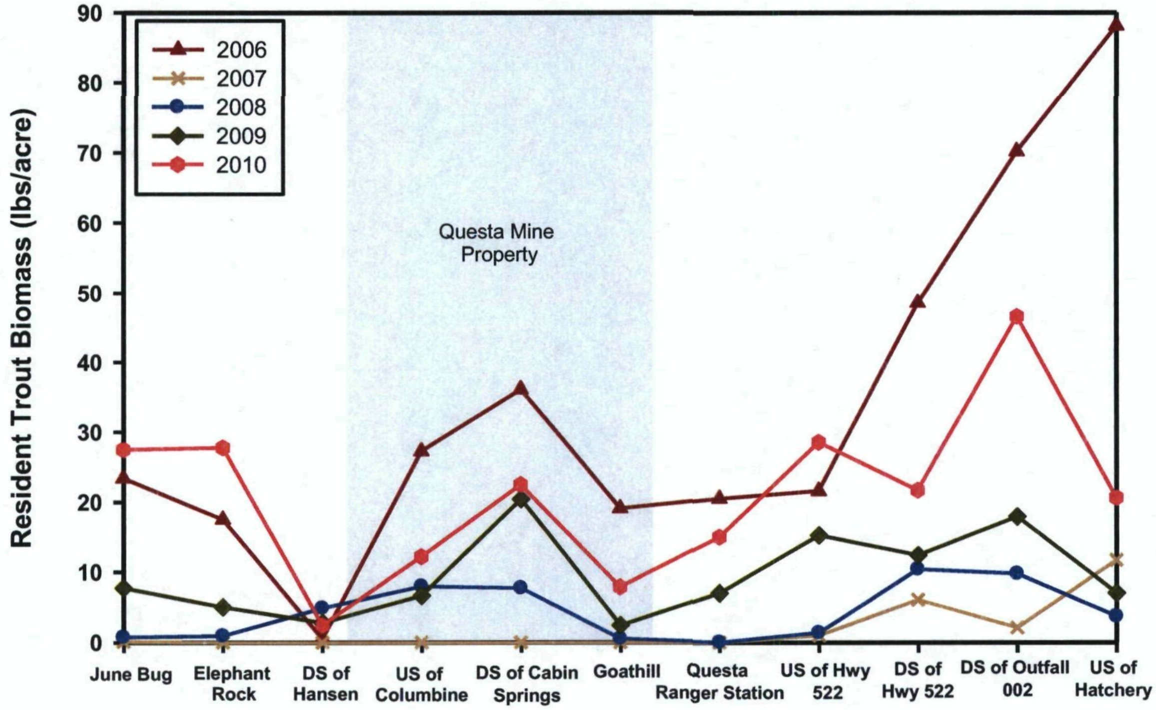
Fish population data from fall 1997 through fall 2010 collected by GEI were evaluated to determine recent annual variability in fish populations. Only sites currently sampled were evaluated. The fish population data were evaluated by calculating the mean for two time-periods. The first time-period was 1997 through 2001, which corresponds to years prior to the initiation of the RI. The second time-period was 2002 through 2009, which corresponds to the years after the initiation of the RI and includes additional sampling sites. Both time-periods were then compared to data collected in 2010.

Fish population data were also collected from 1997 through 2009 during late summer or fall by NMDGF (1997, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, and 2009) near the sites Upstream of Town, Downstream of Hansen Creek, Questa Ranger Station, and Upstream of the Hatchery in odd years, and near the Downstream of Hatchery Site in 2002, 2004, 2006, and 2009. Red River fish populations were not sampled by NMDGF in 2010 (Eric Frey, NMDGF, personal communication), thus, recent trends in fish data collected by NMDGF were not evaluated in this report. Comparisons between GEI and NMDGF data have been made in the past and have demonstrated similar trends (GEI 2008, 2010).

Fish population data from spring 1997 (CEC 1997) are not included in this analysis as the spring data are not directly comparable to data collected in fall. The presence of YOY fish tends to produce a seasonal trend of fewer fish being collected in spring than fall in any given year, which would complicate annual comparisons using both spring and fall data. A separate analysis of spring data was not conducted because of the single spring sampling event.

5.1.1 Overall Trends

In 2007, 2008, and 2009, few fish were present throughout the Red River study area, which was likely the result of the mudslides from the hydrothermal scar on Hot-n-Tot Creek in summer 2007, and the subsequent heavy sediment load into the Red River (GEI 2008). The resident trout population in 2010 demonstrates a substantial increase in biomass and density from 2009, 2008, and 2007, when resident trout were absent from some reaches (Figure 9; GEI 2008, 2009, 2010). Resident trout biomass and density in 2010 was greater than or equal to values observed in 2007, 2008, and 2009 at 10 of the 11 monitoring sites (GEI 2008, 2009, 2010). Although the resident trout population has increased the last few years, the population has not yet completely recovered to levels seen in 2006, as the biomass and density levels in 2010 were less than levels in 2006 at most sites (Figure 9; GEI 2008). The gradual increases in density and biomass in 2008, 2009, and 2010 demonstrate that the resident trout population is slowly recovering as habitat conditions improve.



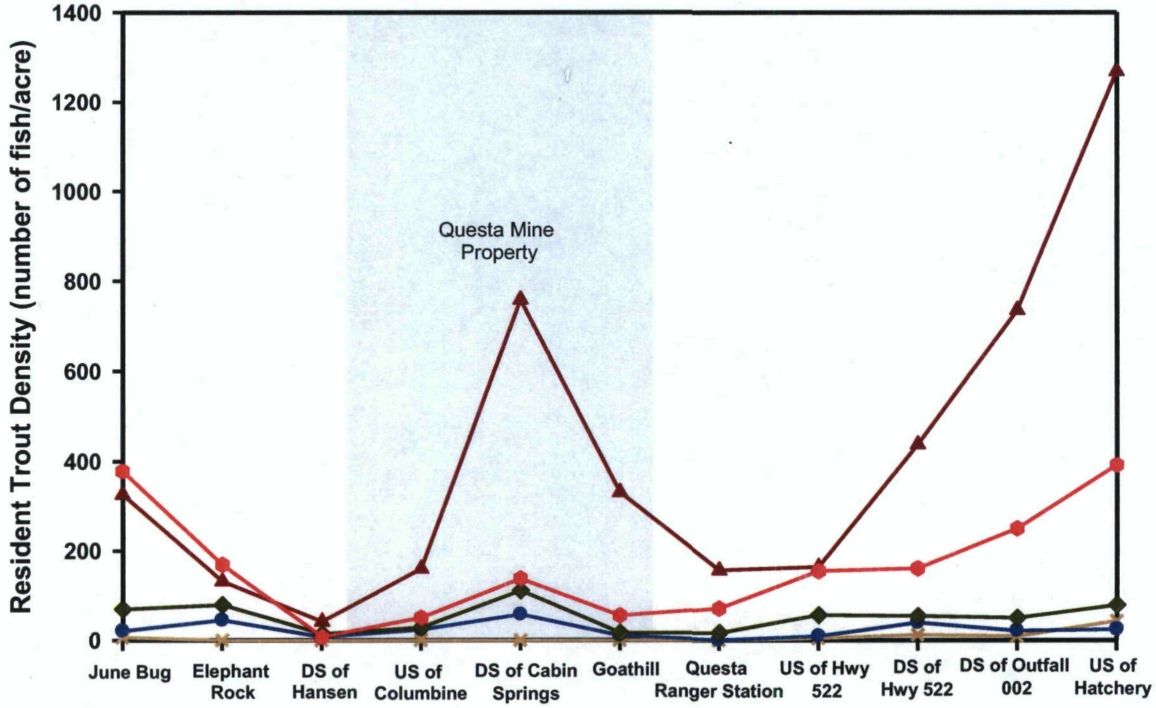


Figure 9: Comparison of resident trout biomass (lbs/acre) (top) and resident trout density (number of fish/acre) (bottom) among sites for fish data collected by GEI in 2006 through 2010.

Over the monitoring period, the patterns in both resident trout biomass and density suggest there may be at least three sections of the Red River that consistently exhibit negative impacts to aquatic biota, which include 1) downstream of the Town of Red River, 2) downstream of Hansen Creek, and 3) downstream of Capulin Canyon and Spring 13. The fish data from 1997 through 2010 collected by GEI (Figure 10) indicate that the natural hydrothermal scars continue to result in a substantial negative impact to the aquatic biota of the Red River (CEC 2001). The data from 1997 through 2009 collected by NMDGF also demonstrate higher density and biomass of fish upstream of the scars and in the furthest downstream reaches of the river (GEI 2008, 2010).

Our earlier reports evaluating data from 1997 through 2000 (CEC 2001) suggested that initial impacts occurred near the Town of Red River from Bitter Creek and/or Hot-n-Tot Creek that resulted in the reductions in trout populations evident at the June Bug Site. In 2010, the density and biomass of resident trout at the June Bug Site were greater than the means from 1997 through 2001 and 2002 through 2009 time-periods (Figure 10). The higher values observed at the June Bug Site compared to previous time-periods and compared to a number of other sites on the Red River in 2010, indicates that upstream impacts were not as evident at the June Bug Site in 2010 as in the past. However, values in 2010 were still less than those observed upstream of the Town of Red River in the past (CEC 2001), indicating that impacts from the Town of Red River, Bitter Creek and/or Hot-n-Tot Creek still occur at the June Bug Site.

The Hot-n-Tot Creek scar deposited substantial sediment into the Red River in the summer of 2007, and zero and one resident trout were collected at the June Bug and Elephant Rock sites in fall 2007, respectively. Density and biomass increased slightly at both of these sites in 2008 and 2009, before a substantial increase in 2010 to values greater than in 2006 (Figure 9), prior to the slide. Density and biomass values in 2010 had recovered to values greater than in previous time periods at the June Bug Site; however, values at the Elephant Rock Site in 2010 were still less than those observed from 1997 through 2001. This could be related to the fish population still recovering at the Elephant Rock Site from the 2007 Hot-n-Tot Creek mudslides, the filling in with sediment of some pool habitat features, or both.

The second area of impact evident from past data was near Hansen Creek. The Downstream of Hansen Creek Site consistently contains low density and biomass of resident trout (GEI 2008, 2009, 2010). This trend continued in 2010 (Figure 10).

There has usually been some recovery at the three sites in the reach of the river adjacent to the mine at the Upstream of Columbine Creek, Downstream of Cabin Springs, and Goathill sites (Figure 10). This trend continued in 2010 with higher density and biomass values at the three sites adjacent to the mine than at the Downstream of Hansen Creek Site (Figure 10). Despite these higher values compared to the Downstream of Hansen Creek Site, density and biomass values in 2010 at the Upstream of Columbine and Goathill sites were low compared to values observed in 1997 through 2001.

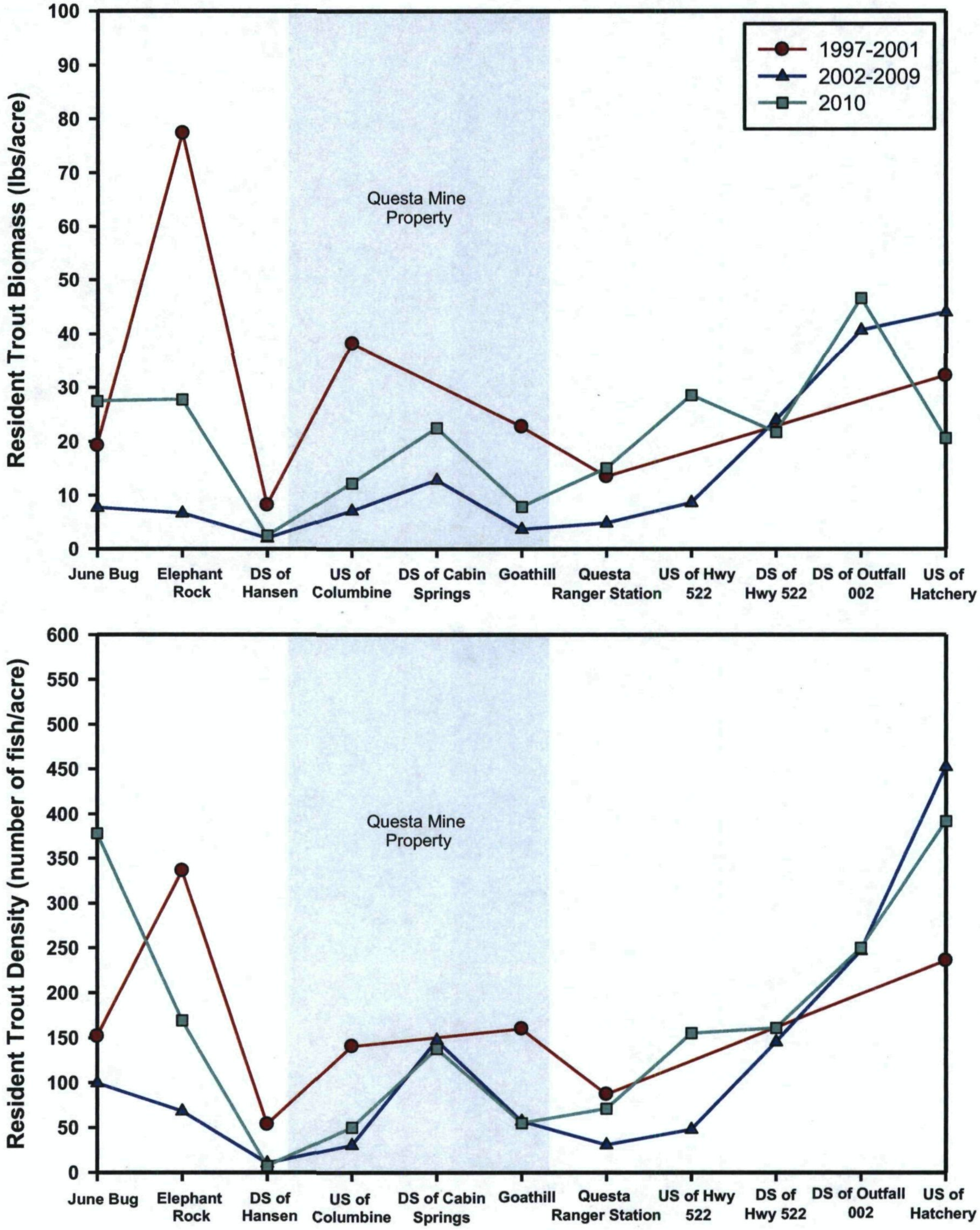


Figure 10: Comparison of resident trout biomass (lbs/acre) (top) and resident trout density (number of fish/acre) (bottom) among sites for fish data collected by GEI from 1997 through 2001, 2002 through 2009, and in 2010.

At the next site downstream, the Questa Ranger Station Site, trout population levels decreased substantially from the Goathill Site for the 1997 through 2001 time-period and had similar values to the Goathill Site for the 2002 through 2009 time-period (Figure 10). In 2010, resident trout density and biomass at the Questa Ranger Station Site was higher than at the Goathill Site, higher than the mean values for the 2002 through 2009 time-period, and similar to the mean values for the 1997 through 2001 time-period. However, density and biomass values at the Questa Ranger Station Site were still less than a number of the other sampling sites on the Red River. The decreasing longitudinal trend from 1997 through 2001 and the continued low values from 2002 through 2009 indicate a third area of impact, despite improvements to the resident trout population in this reach in 2010. Hydrothermal scars in Capulin Canyon and areas of upwelling groundwater near Spring 13 that discharge into the Red River just upstream of the Questa Ranger Station Site is likely contributing to the reduced trout population at this site, especially during base flow periods.

Statistical analyses of the data from 1997 through 2010 support the conclusions for trends in trout populations. Analysis of variance results indicated that long-term mean biomass was significantly ($p < 0.05$) lower at the June Bug Site than at the Elephant Rock, Downstream of Outfall 002, and Upstream of Hatchery sites (Figure 11), indicating that the first substantial impacts to the Red River fish community occurs near the Town of Red River, upstream of mine operations. The June Bug Site also had a significantly lower long-term mean density than the Upstream of Hatchery Site ($p < 0.05$) (Figure 11). The Downstream of Hansen Creek Site had a significantly lower mean biomass and density value than the Elephant Rock Site and a number of the sites further downstream ($p < 0.05$) (Figure 11), confirming that inputs from Hansen Creek appear to have had a negative impact on the resident trout population over the monitoring period. The Questa Ranger Station Site also had a significantly lower mean biomass value than the Elephant Rock Site and significantly lower mean density and biomass values than a few of the downstream sites ($p < 0.05$) (Figure 11). These lower density and biomass values at the Questa Ranger Station Site indicate that Capulin Canyon and the upwelling groundwater near Spring 13 also appears to reduce fish populations in the Red River. Three of the four sites downstream of Cabresto Creek had the highest long-term mean biomass and density values of all the sites, indicating that some recovery of the resident trout populations occurs throughout this reach.

The Red River fish population varied substantially both spatially and temporally for the 1997 through 2010 time-period (Figure 11). The 10^{th} and 90^{th} percentiles of biomass data at the Elephant Rock Site ranged from zero to greater than 100 lbs/acre, and the Downstream of Outfall 002 and Upstream of Hatchery sites ranged from near zero to between 75 and 90 lbs/acre (Figure 11). Density was also highly variable at these two downstream sites and at the Downstream of Cabin Springs Site, where the 10^{th} and 90^{th} percentiles ranged from approximately 0 to 760 fish/acre (Figure 11). Density and biomass varied the least at the Downstream of Hansen Creek Site, where values were low during most years, compared to the other sites.

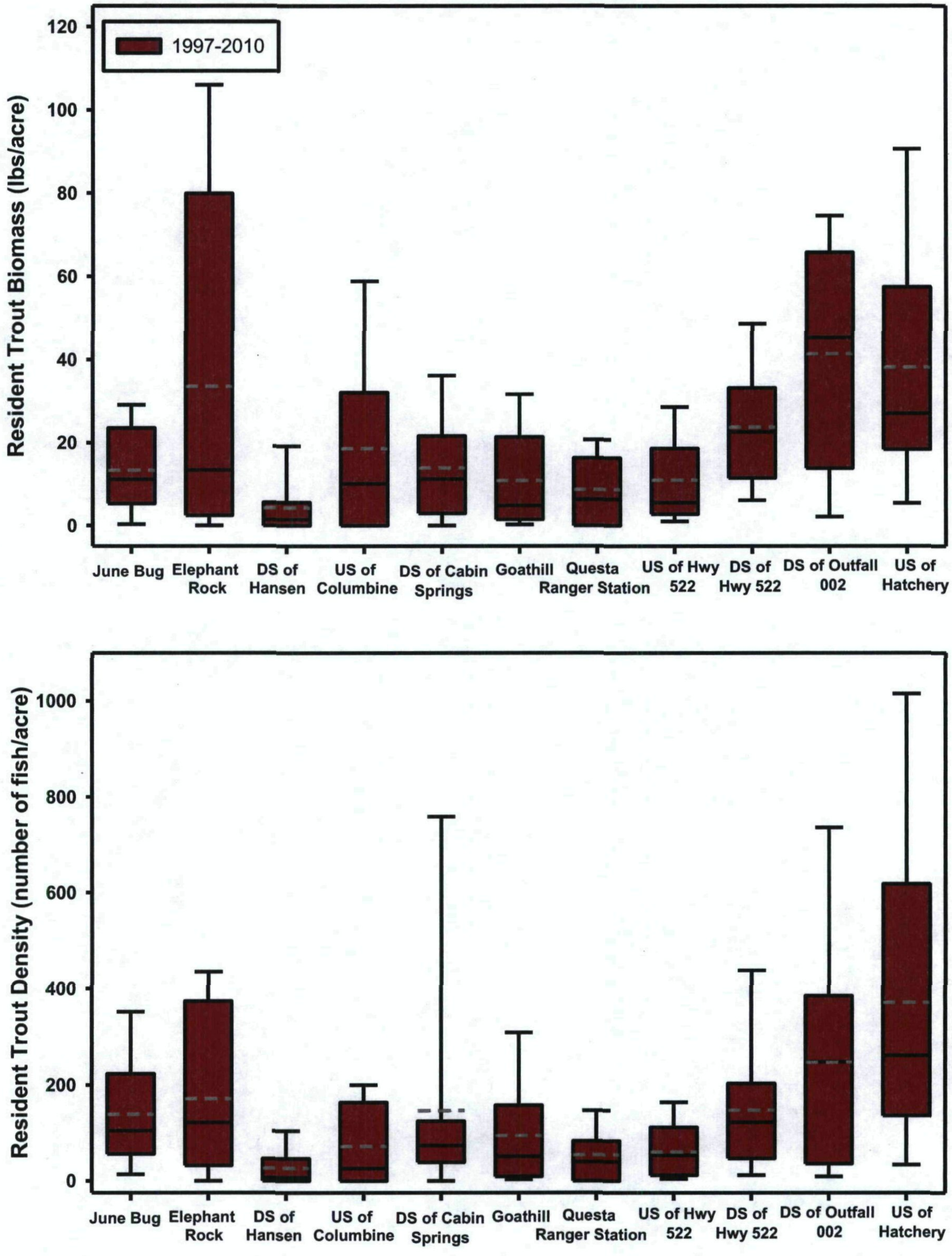


Figure 11: Box plots of the resident trout biomass and density data from 1997 through 2010 *for each Red River site. The box represents the 25th and 75th* percentiles, the whiskers represent the 10th and 90th percentiles, the black line in the box represents the median, and the dotted grey line represents the mean.

At most sites, there was higher mean density and biomass in 1997 through 2000 compared to later years (Figure 12). However, the resident fish data from 2006 had a significantly higher mean density and biomass compared to most years ($p < 0.05$) (Figure 12). Mean density and biomass values from 2007, 2008, and 2009 were the lowest over the monitoring period and were significantly lower than many of the years from 1997 through 2000 and the mean values in 2006 ($p < 0.05$) (Figure 12). Mean biomass and density in 2010 were the sixth and fifth highest mean values observed over the 14-year monitoring period, respectively (Figure 12). Mean density in 2010 was significantly less than in 2006 ($p < 0.05$), while mean biomass in 2010 and 2006 were statistically similar ($p > 0.05$). The mudslides in the summer of 2007 were the likely cause of the 98 percent reduction in the number of resident trout collected at the monitoring sites between 2006 and 2007 (GEI 2008). Resident trout density and biomass in 2010, while less than in 2006, have recovered to levels similar to those observed in years prior to the 2007 mudslides.

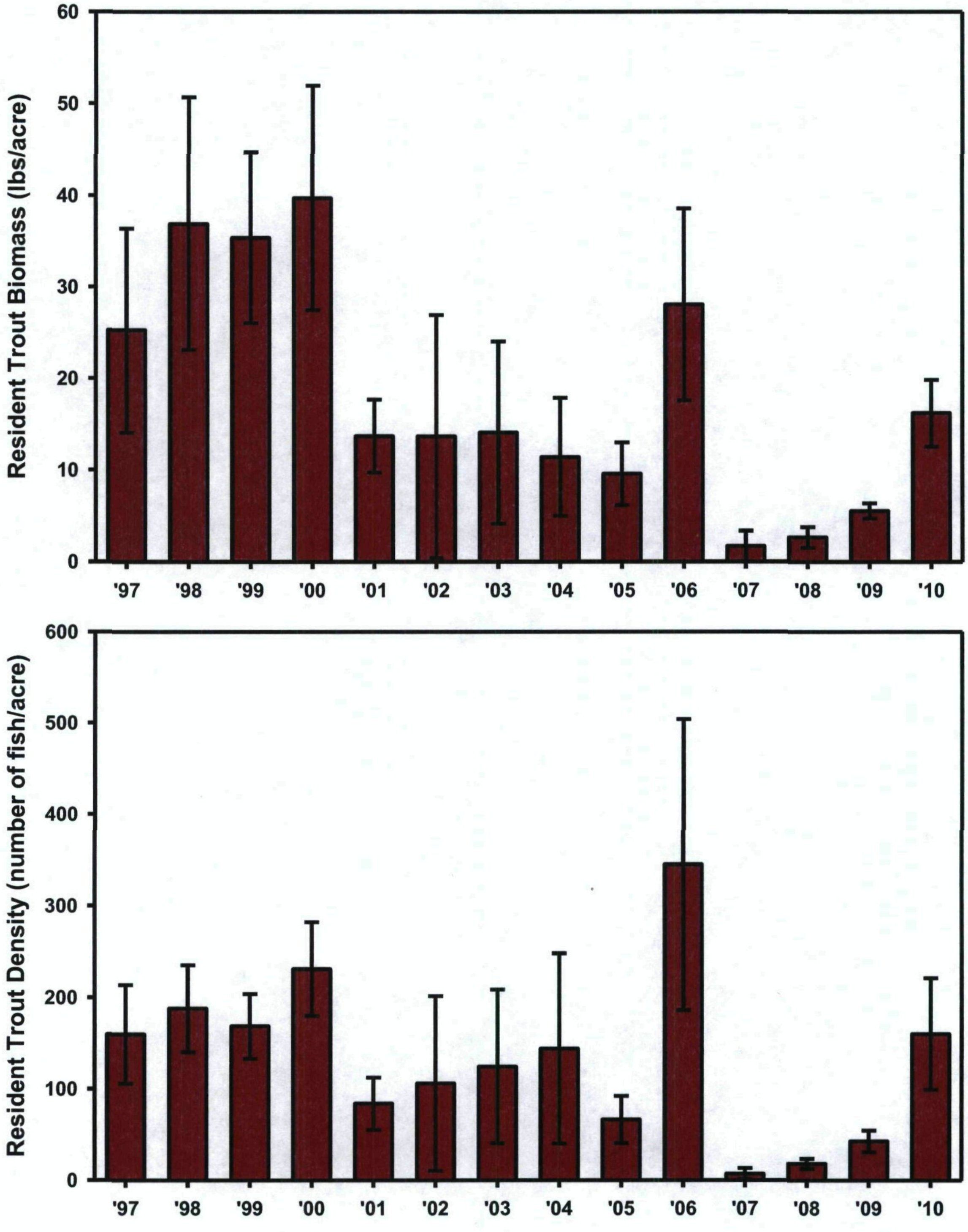


Figure 12: Mean resident trout biomass and density for the seven Red River sites with annual data from 1997 through 2010. Error bars represent the standard error.

5.2 Habitat

Habitat data were collected from 2002 through 2010 and were evaluated to determine the annual variability in habitat characteristics. Only sites currently sampled were evaluated. Most habitat metrics varied little annually, thus only substrate characteristics were evaluated. Percent embeddedness, percent riffle embeddedness, percent fines by area, and percent fines by grid generally demonstrate the same trends among sites, thus only the percent embeddedness metric is discussed here. Evaluations focused on annual comparisons of percent embeddedness data as related to flow and mudslides.

5.2.1 Overall Trends

Sediment evaluations were not conducted as part of the study in 2001, but field notes indicated that sediment had been added to the river from thunderstorms located over the hydrothermal scars, which had filled the pools at the Elephant Rock Site. A severe drought year occurred in 2002 in New Mexico with substantially reduced spring runoff flows (Figure 6). The reduced runoff flows in spring 2002 resulted in substantial sediment accumulation in the Red River from the thunderstorms and subsequent sediment inputs in 2001 and additional thunderstorms in 2002 that also caused mudslides and sediment inputs from the hydrothermal scars. Percent embeddedness was between 70 and 90 percent at the first five sites downstream of the Hot-n-Tot Creek scar in 2002 (Figure 13). Spring runoff flows were also low in 2003 and 2004 (Figure 6) and percent embeddedness values remained high at the five upstream sites (Figure 13). A high spring runoff flow in 2005 flushed much of the excess sediment at the upstream sites out of the study reach and values remained similar in 2006, except at the Downstream of Hansen Creek Site where embeddedness was high.

In 2007, percent embeddedness was high at all sites from the Elephant Rock Site downstream through the study reach (Figure 13), because of sediment inputs from the summer 2007 mudslides on Hot-n-Tot Creek. High spring runoff flows in 2008, 2009, and 2010 (Figure 6) gradually removed excess sediment from the study reach, resulting in embeddedness levels in 2010 that were similar to the base levels observed in 2005 and 2006 at most sites (Figure 13). While embeddedness values have varied substantially at the six most upstream sites from 2002 through 2010, embeddedness values typically varied little from the Questa Ranger Station Site downstream through the study reach (Figure 13), except in 2007 following the large mudslides.

Evaluation of sediment and fish population data from 2002 through 2010 indicates that a combination of increased sedimentation and decreased water quality from periodic mudslides, limits the resident trout population in the Red River (Conklin and Mullen, *in-press*). Drought and the lack of sizeable spring runoff flows appeared to exacerbate the problem of high sedimentation levels during some years whereas high spring runoff flows following the 2007 mudslides resulted in a substantial reduction in embeddedness levels and substantial recovery in the resident trout population by 2010 (Conklin and Mullen, *in-press*).

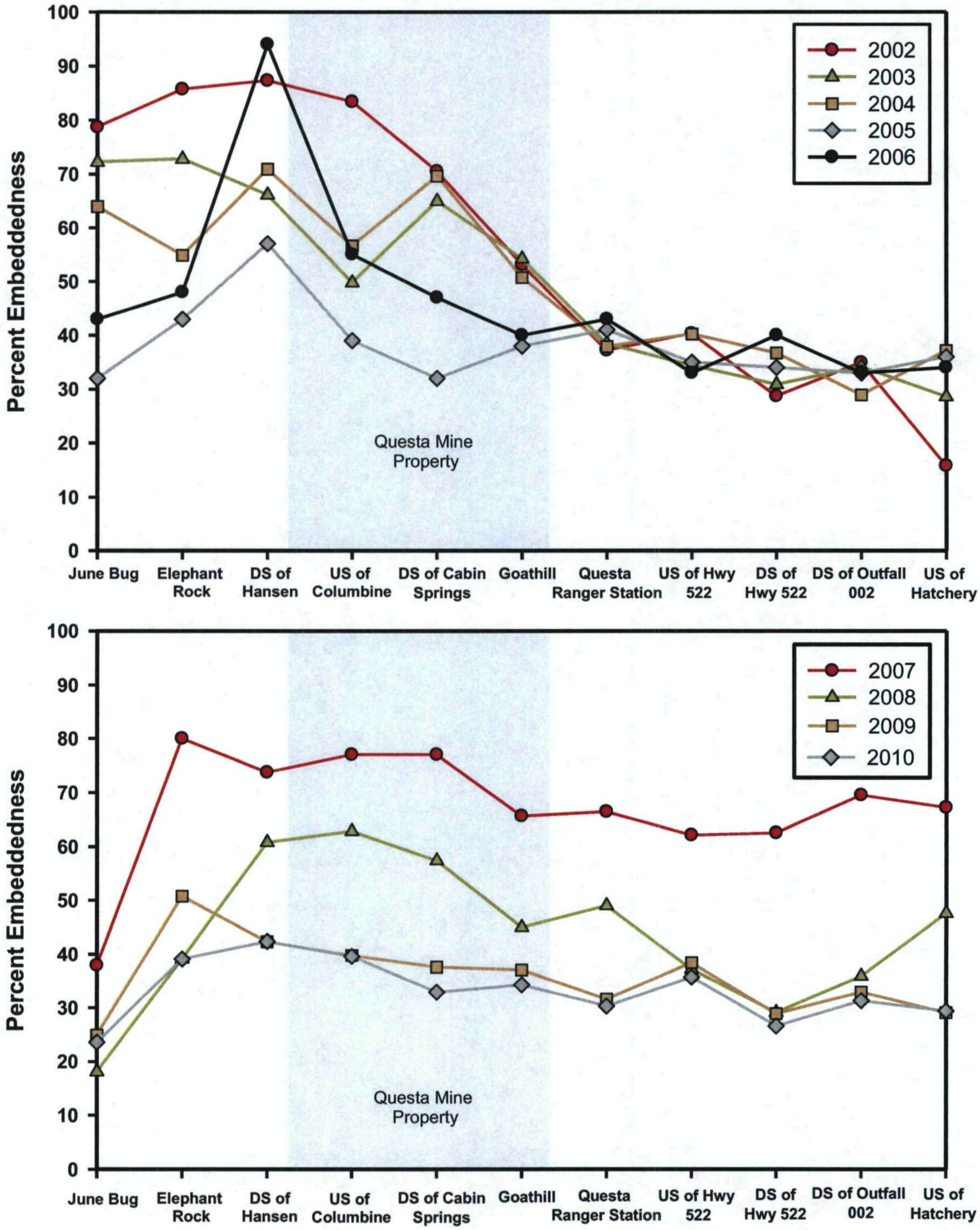


Figure 13: Percent embeddedness at sites located along the Red River, from 2002 through 2010.

5.3 Benthic Invertebrates

Benthic invertebrate data from early winter 1995 (Woodward -Clyde 1996) and fall 1997 through fall 2010 (CEC 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010) were used to evaluate annual variability in invertebrate populations. Only sites currently sampled were evaluated. Benthic invertebrate data were evaluated by dividing the data into two groups. The first corresponded to data prior to the initiation of the RI (1995 through 2001) and the second corresponded to data collected after the initiation of the RI (2002 through 2009). Data from 2010 were compared to the means of these two time-periods.

5.3.1 Overall Trends

The patterns in benthic invertebrate parameters in past years suggest three areas of impact to the Red River, similar to the trends for fish data. The reaches of the river downstream of the Town of Red River, downstream of Hansen Creek and downstream of Capulin Canyon consistently indicate lower density of invertebrates. Other parameters were less consistently affected, but indicate similar trends.

5.3.1.1 Density and Number of Taxa

Densities have varied over the years, but the highest mean densities were observed at the Elephant Rock, Downstream of Highway 522, Downstream of Outfall 002, and the Upstream of Hatchery sites for the 1995 through 2001 and 2002 through 2009 time-periods (Figure 14). The lowest mean density during these times was observed at the Questa Ranger Station Site. Mean density was also low at the Downstream of Hansen Creek Site in the 2002 through 2009 time-period. Number of taxa varied less longitudinally among sites than density (Figure 15). The lowest mean number of taxa values in 1995 through 2001 and 2002 through 2009 occurred at the Downstream of Hansen Creek, Upstream of Columbine, and Questa Ranger Station sites.

During most years, density, number of taxa, or both were relatively low at the June Bug Site, just downstream of the Town of Red River, as compared to the next downstream site (Figures 14 and 15) and past data of benthic invertebrate populations upstream of town (GEI 2008). This overall pattern demonstrates an overall impact to benthic invertebrate populations near the Town of Red River.

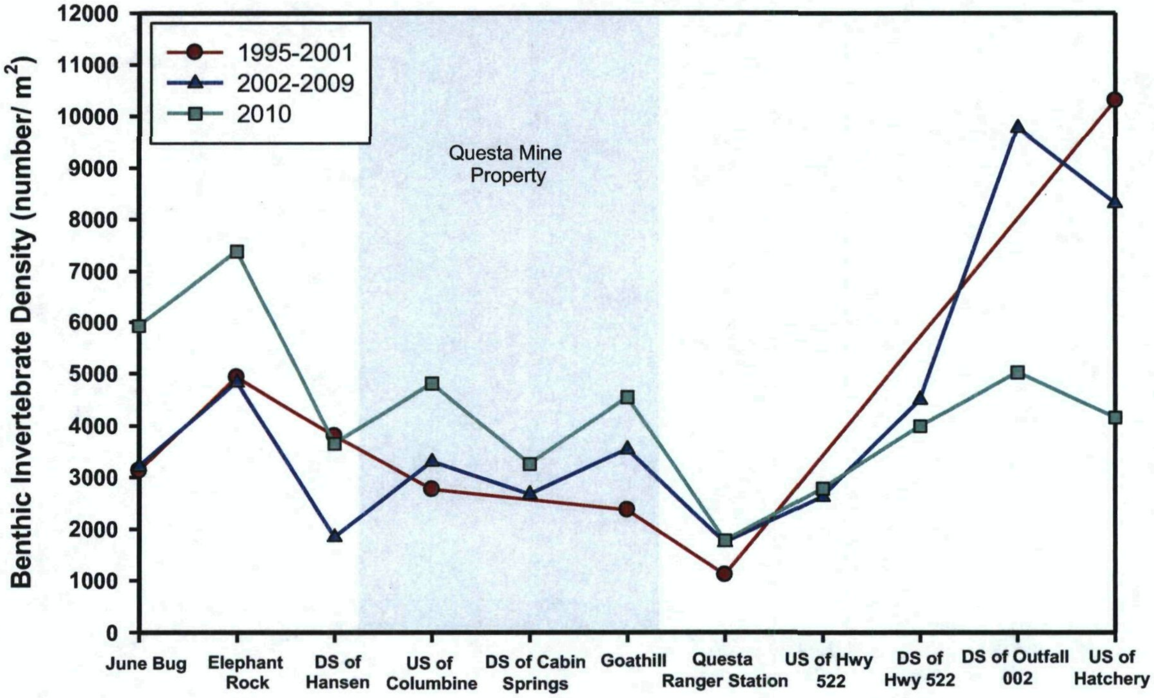


Figure 14: Comparison of benthic invertebrate density (#/m2). Data collected by GEI in fall 1997 through 2010, and at corresponding sites by NMED and CMI in December 1995.

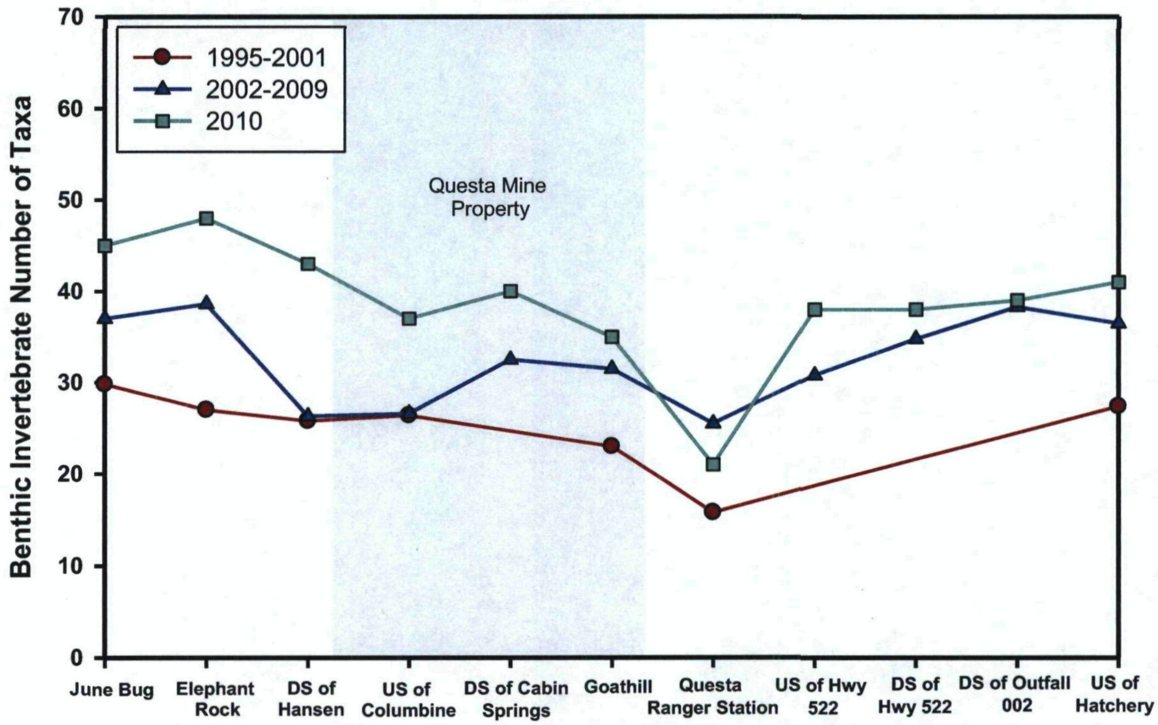


Figure 15: Comparison of number of benthic invertebrate taxa. Data collected by GEI in fall 1997 through 2010, and at corresponding sites by NMED and CMI in December 1995.

There was also a substantial decrease in density and number of taxa between the site located upstream of Hansen Creek (Elephant Rock Site) and the site located downstream of Hansen Creek for both time-periods (Figures 14 and 15). This trend demonstrates impacts in this section of the river, from Hansen Creek or upwelling groundwater in this vicinity.

The Questa Ranger Station Site had low density and number of taxa values for both time-periods (Figures 14 and 15). This site is downstream of Capulin Canyon and Spring 13 and has consistently represented one of the most impacted sections of the Red River for benthic invertebrates. Low benthic invertebrate population parameter values were also found in this section of the river near the Questa Ranger Station Site by Jacobi et al. (1998).

The trends in density and number of taxa in all of the data are consistent in exhibiting substantial recovery at the site upstream of the fish hatchery. This site is downstream of the confluence with Cabresto Creek. The data indicate the recovery pattern is enhanced by dilution water from Cabresto Creek, irrigation return flows, and groundwater discharge, which allows the benthic invertebrate populations to recover to levels comparable to or better than those found in the reaches of the Red River upstream of Hansen Creek. This trend was also demonstrated by Jacobi et al. (1998).

In fall 2010, density was highly variable with the highest values occurring at the June Bug and Elephant Rock sites, and the lowest values occurring at the Questa Ranger Station and Upstream of Highway 522 sites (Figure 14). These lower density values occurred at sites located near the Capulin Canyon and Spring 13 areas of historic impacts.

The number of taxa in fall 2010 followed the trends from 1995 through 2001 and 2002 through 2009 time-periods (Figure 15). The number of taxa decreased at the Downstream of Hansen Creek Site from the next site upstream and the lowest number of taxa value occurred at the Questa Ranger Station Site in 2010. Both density and number of taxa were higher in 2010 at most sites than mean values for the 1995 through 2001 and 2002 through 2009 time-periods.

5.3.1.2 Number of EPT taxa

The trends for the number of EPT taxa resemble the trends observed for the number of taxa. From 1995 through 2001, the mean number of EPT taxa was lowest at the Elephant Rock and the Questa Ranger Station sites (Figure 16). From 2002 through 2009, mean number of EPT taxa was lowest at the Downstream of Hansen Creek Site. Although the lowest mean values of EPT taxa were not consistent among time-periods, overall trends indicated less healthy communities at the site downstream of Hansen Creek and the site downstream of Capulin Canyon. Some recovery in the mean number of EPT taxa was evident in the reaches of the Red River adjacent to the mine property (Figure 16) and limited recovery was evident at sites downstream of the confluence with Cabresto Creek, for both time-periods (Figure 16).

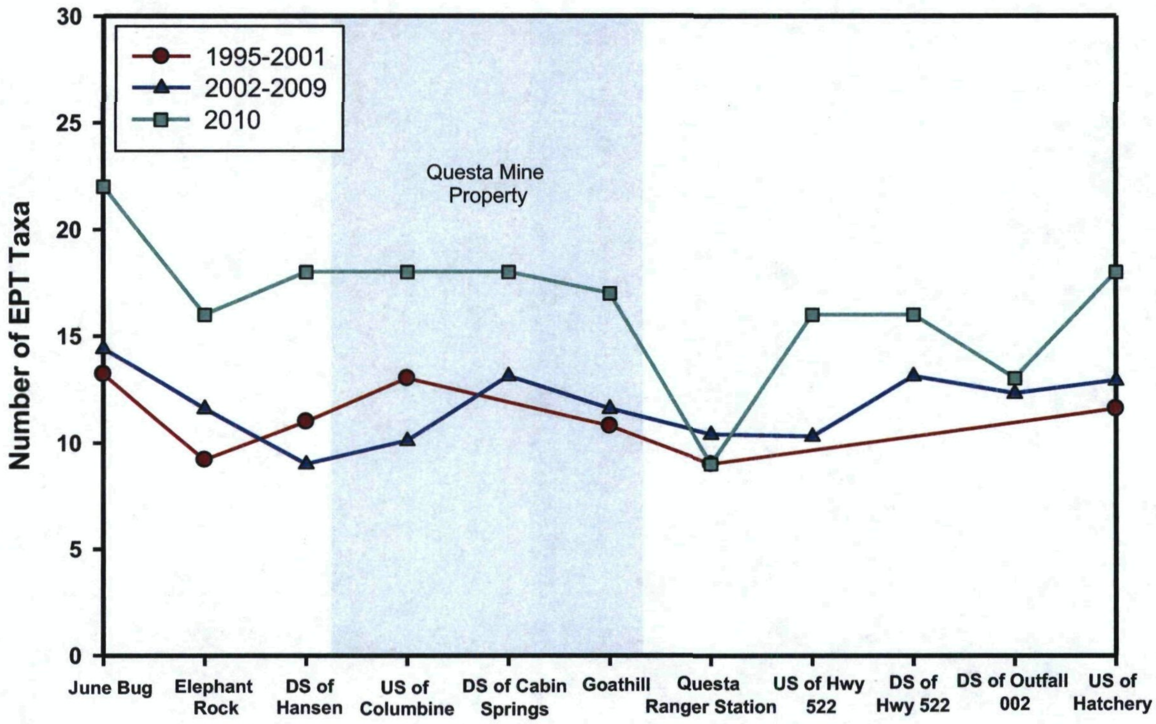


Figure 16: Comparison of number of EPT taxa. Data collected by GEI in fall 1997 through 2010, and at corresponding sites by NMED and CMI in December 1995.

In 2010, the longitudinal trends in the number of EPT taxa closely resembled the trends in EPT taxa from the 1995 through 2001 and 2002 through 2009 time-periods (Figure 16). The number of EPT taxa was lower at the Elephant Rock Site compared to the next site upstream, and the lowest number of EPT taxa value occurred at the Questa Ranger Station Site in 2010. The number of EPT taxa at the Downstream of Outfall 002 Site was also low compared to the sites upstream and downstream from it. The numbers of EPT taxa observed in 2010 were higher than the two previous time-periods for all of the sites, except the Questa Ranger Station Site.

5.3.1.3 Mayfly Abundance

The longitudinal trends in mayfly abundance, one of the more sensitive indicators of metals stress, further indicated the same three areas of impact. The lowest values for both time-periods were at the June Bug, Downstream of Hansen, and the Questa Ranger Station sites (Figure 17). Some recovery was observed at the Elephant Rock Site, adjacent to the mine property, and downstream of Cabresto Creek. The similarity of the trends for both time-periods indicates areas of impact to mayfly abundance in the Red River downstream of the Town of Red River, Hansen Creek, and Capulin Canyon.

Mayfly abundance was highly variable among sites in 2010, but was greater than the long-term means of both time-periods at each site (Figure 17). The lowest mayfly abundance values were observed at the Questa Ranger Station and Upstream of Highway 522 sites. A decline in mayfly abundance occurred between the Elephant Rock and Downstream of Hansen Creek sites. The longitudinal trend in mayfly abundance in 2010 further indicates an area of impact downstream of Hansen Creek and downstream of Capulin Canyon and Spring 13.

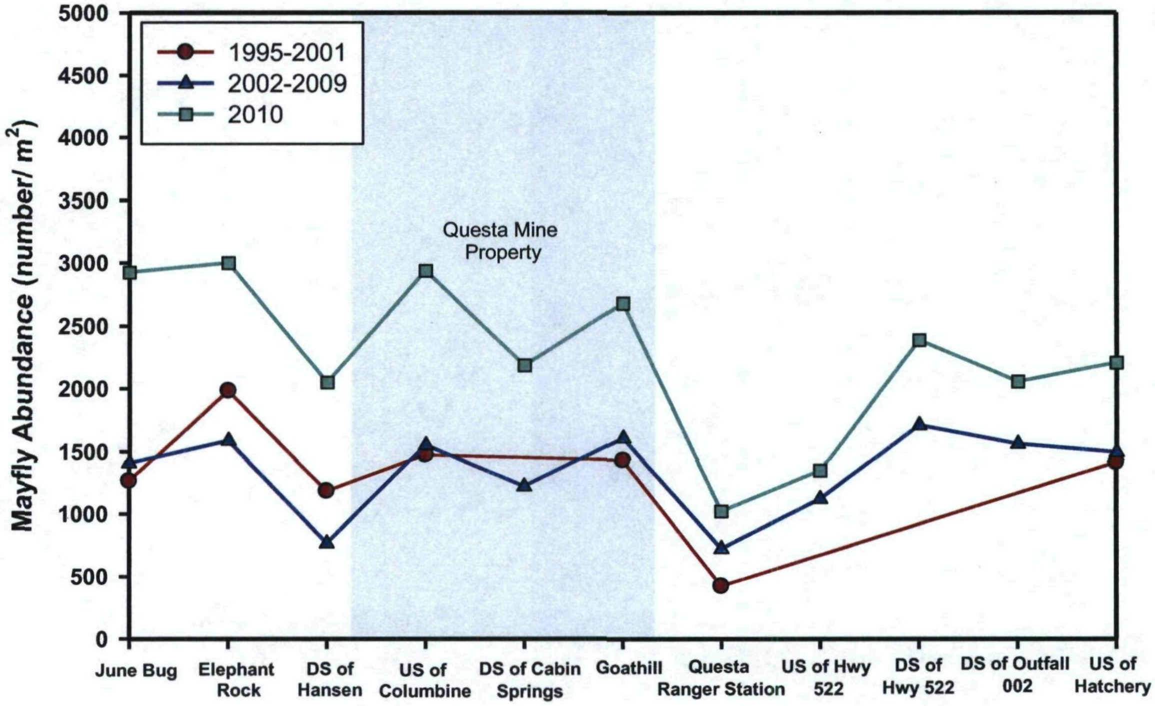


Figure 17: Comparison of mayfly abundance (#/m²). Data collected by GEI in fall 1997 through 2010, and at corresponding sites by NMED and CMI in December 1995.

5.3.1.4 Metals Intolerant Taxa

The longitudinal trend for the number of metals intolerant taxa indicated lower values compared to adjacent sites at the Downstream of Hansen and the Questa Ranger Station sites for both time-periods (Figure 18). The number of metals intolerant taxa remained low at sites downstream of the Questa Ranger Station Site for both time-periods. The lower values at the Downstream of Hansen and Questa Ranger Station sites suggest areas of impact in the Red River downstream of Hansen Creek and Capulin Canyon. Some recovery was observed in the reach adjacent to the mine property, but little recovery was observed downstream of Cabresto Creek (Figure 18).

The number of metal intolerant taxa was highly variable in 2010, but values were similar to or greater than most values from the 1995 through 2001 and 2002 through 2009 time-periods (Figure 18). The number of metal intolerant taxa was lowest in 2010 at the Questa Ranger Station and Downstream of Outfall 002 sites with two and three metal intolerant taxa present, respectively. The number of metal intolerant taxa varied from five to seven at the remaining Red River sites in 2010.

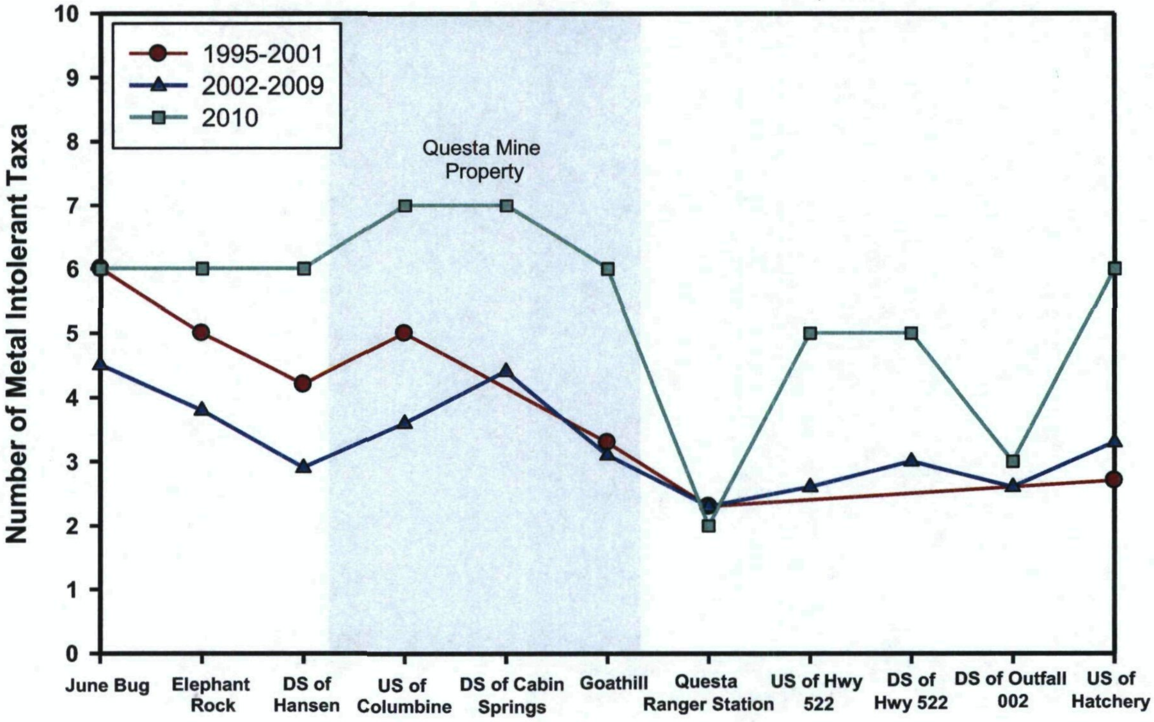


Figure 18: Comparison of metals intolerant taxa. Data collected by GEI in fall 1997 through 2010, and at corresponding sites by NMED and CMI in December 1995.

5.3.1.5 2010 Trend

The benthic invertebrate data from 2010 were similar to or greater than mean values from the 1995 through 2001 and 2002 through 2009 time-periods (Figures 14-18). The similarity between longitudinal trends in 2010 and historic trends depended on the metric assessed. The downstream of Hansen Creek and downstream of Capulin Canyon areas of impact, observed in the historic trends were also generally observed in the 2010 data. The area of impact downstream of the Town of Red River observed in the historic trends was not as evident in the 2010 data as in past years, as metric values were similar between the June Bug and Elephant Rock sites. Overall, the benthic invertebrate community in 2010 appeared healthier than in recent years; however, impacts were still noticeable, particularly downstream of Capulin Canyon.

5.4 Potential Limiting Factors

Multiple physical and chemical factors appear to be influencing the distribution of trout and benthic invertebrates along the length of the Red River. The factors of influence change in importance from year to year, as is seen in many natural populations (Hall and Knight 1981). Correlation analysis and all possible regressions analysis were conducted by CEC (2005a) using flow data, habitat data, and water and sediment chemistry data (25 metals plus field parameters) collected in 2002 and 2003 during the RI at sites co-located with fish and benthic invertebrate sampling. Below are discussions of the factors that appear to be having the most influence on fish and invertebrate communities in the Red River.

5.4.1.1 Flow

Flow is an important factor in determining year-to-year trends in trout populations because high water years often reduce the abundance of YOY trout (Chadwick et al. 2004; Latterell et al. 1998) and high flows are important in flushing out excess sediment and maintaining and structuring stream channels. Previous reports have demonstrated the influence of peak runoff flows on YOY trout density in the Red River (CEC 2005a), with fewer YOY trout in years of higher runoff. Fish population data from 2006 further supported this relationship (GEI 2008). Based on daily discharge data from two USGS gages on the Red River within the study area, flows in spring 2006 were below average and were lower than what had been observed since 2002. Likely due to the low spring runoff flows, abundant YOY brown trout were collected at most sites in fall 2006.

Although 2007 peak and monthly flows in the Red River were lower than the median flow for the period of record (1915 to present), localized thunderstorms produced heavy rains during the summer over the Hansen and Hot-n-Tot Creek hydrothermal scars. This resulted in extensive mudslides in the Red River Canyon between Red River and Questa. Much of the material was deposited directly into the stream, and heavy sedimentation, pool filling, and altered channel morphology were apparent during 2007 surveys. Juvenile brown trout are most susceptible to displacement or physical injury from spates for a short time after emergence (Heggenes 1988). They would have been largely immune to the slightly higher flows caused by the 2007 summer rains, which only reached approximately 60 cfs and were lower than flows that usually occur during spring runoff. Instead, limited physical habitat and water chemistry conditions during and after the storm likely reduced the survival of juvenile and adult fish. Only one or two YOY brown trout were collected in 2007, far fewer than in past years.

In 2008 and 2009, the resident brown trout population responded slightly, increasing in density compared to 2007 and with a few YOY present in both years. Peak runoff flows in 2008 and 2009 were greater than the peak median flow over the period of record (Figure 6). The limited YOY present in 2008 and 2009 was probably a combination of only a few adults present in the study area to spawn and the relatively high peak runoff flows. In 2010, a number of YOY were present at 9 of the 11 sites, and density and biomass levels were comparable to years prior to the 2007 mudslides. The increased YOY in 2010 compared to 2008 and 2009 can likely be attributed to more spawning adults in the study area, high spring runoff flows in 2008 and 2009 that flushed out excess sediment, and slightly lower spring runoff flows in 2010. The presence of YOY in 2010 at most sites and in 2008 and 2009 at some sites, demonstrates spawning and recruitment success in the Red River and/or recruitment from upstream sources and tributaries.

The literature is more equivocal with respect to invertebrates. Low flows can result in an increase, a decrease, or no change in macroinvertebrate communities (Dewson et al. 2007). High flows such as spates or floods do appear to reduce macroinvertebrate density and diversity, but communities appear to recover rapidly (Giller et al. 1991; Jowett 2003). On the other hand, Ward (1975) demonstrated that the macroinvertebrate community in a Colorado stream varied little in two years (1945 and 1974) despite the construction of an upstream reservoir, and different precipitation and flow regimes. Benthic invertebrate density and number of taxa have both varied over the monitoring period, but neither was significantly related to the annual peak runoff flow or the minimum flows from 1997 through 2010. The lack of significant relationships between benthic invertebrate metrics and peak runoff flow is not unexpected, given that spring sampling occurs prior to the runoff flow and that fall sampling occurs well after the spring runoff flow, which allows time for the benthic invertebrate community to recover. The lack of a significant relationship with minimum flows suggests that minimum flows are sufficient to maintain the benthic invertebrate density and number of taxa.

5.4.1.2 Sediment

Embeddedness can negatively affect juvenile trout by reducing habitat and food availability. Juvenile trout use interstitial spaces for cover and sedimentation makes these spaces less suitable. Adult trout can select habitat on a reach scale and may migrate to select foraging habitat (Gowan and Fausch 2002). With lower invertebrate density at many sites in 2007, especially at the upper sites, trout may have emigrated from the reaches of the Red River in the study area to more profitable foraging sites downstream or in the Rio Grande. Invertebrate densities have recovered since fall 2007, and the resident fish population in 2010 has recovered to levels similar to those observed prior to the 2007 mudslides.

Sedimentation is an important factor determining the distribution of fish (Newcombe and MacDonald 1991; Newcombe and Jensen 1996) and appears to drive fish population dynamics in the Red River in some years. For fish, 52 percent of the longitudinal variation in biomass in 2004 was explained by percent riffle embeddedness (CEC 2005b). In 2005, this number increased to 67 percent. In 2006, a combination of mean maximum depth and embeddedness explained 94 percent of the variation seen in the trout biomass data (GEI 2008). The relationships between fish and embeddedness metrics were not significant ($p > 0.05$) in 2007, 2008 (GEI 2008, 2009) or 2009, most likely because density and biomass values were low at all sites in the Red River in these years. In 2010, percent embeddedness and percent riffle embeddedness explained 48 and 65 percent of the variation in resident trout density ($p = 0.019$ and 0.002), respectively. The relationships between resident trout biomass and embeddedness metrics were not significant ($p > 0.05$) in 2010.

Embeddedness also has negative effects on macroinvertebrates (Waters 1995). Fine sediments smother interstitial habitat (Waters 1995) and deny many taxa access to the hyporheic zone, which is an important refuge from harsh environmental conditions such as flow extremes (Dewson et al. 2007).

For invertebrates in fall 2005, 64 percent and 72 percent of the longitudinal variation in number of taxa and number of EPT taxa was explained by percent embeddedness, respectively. However, in spring and fall 2004, spring 2005, and fall 2006 percent embeddedness was not significantly related to any of the invertebrate parameters. In 2007, riffle embeddedness was significant in explaining the variation for only the percent heptageniids metric ($R^2 = 0.65$). In spring 2008, percent embeddedness was significant ($p < 0.05$) in explaining 56 and 44 percent of the variation in percent mayfly abundance and number of metal intolerant taxa, respectively and riffle embeddedness explained 64 percent of the variation in percent mayfly abundance. Embeddedness metrics were not significant in explaining the variation in any of the benthic invertebrate metrics in fall 2008. In spring 2009, percent embeddedness and percent riffle embeddedness explained 41 and 44 percent of the variation in the number of taxa ($p = 0.035$ and 0.026, respectively), but embeddedness metrics were not significant in explaining variation in the remaining metrics, nor were they significant in explaining the variation in any of the benthic invertebrate metrics in fall 2009. In spring 2010, embeddedness and riffle embeddedness explained 39 and 43 percent of the variation in benthic invertebrate diversity ($p = 0.039$ and 0.027, respectively). No other significant relationships were observed between benthic invertebrate metrics and embeddedness metrics in spring or fall 2010. Overall, results from recent years suggest that embeddedness metrics play a role in structuring the benthic invertebrate community in most years, but the results were not always strong nor were they consistent, indicating that other factors also play a role in structuring the benthic invertebrate community.

5.4.1.3 Water Quality

Episodic summer rainstorms add large amounts of sediment to the Red River while simultaneously degrading water quality and confounding our ability to determine the relative influence of flow, sedimentation, and water quality on fish and invertebrates. Toxicity testing in 2003 demonstrated substantial toxicity in the middle reaches of the river during storm runoff flows, but toxicity testing in fall 2002 during base flow indicated no toxicity in the middle reaches of the Red River. Invertebrate populations in these reaches contained at least some water-quality sensitive species in all years. In 2007, the sliding of the hydrothermal scars temporarily degraded water quality and resulted in stream sedimentation that was still evident in 2008 and to a lesser extent in 2009. Most of the local resident fish population likely perished or migrated downstream because of the mudslides. Water quality and sediment characteristics have improved since the summer 2007 slides and the recovery in the resident trout population is evident in 2010. Invertebrates will recolonize the reaches of the river affected by the mudslides by drifting from upstream reaches. Lower values for some parameters were observed in 2009 at sites that correspond to the areas of impact seen prior to the 2007 mudslides. However, it appears the benthic invertebrate population has recovered from the summer 2007 mudslides as the parameters observed in spring and fall of 2009 and 2010 were similar to or greater than in fall 2006 and spring 2007 (GEI 2008, 2010). Furthermore, benthic invertebrate parameters were typically greater in 2010 than mean values observed during the recent and historical trends time-periods.

5.4.1.4 Habitat

Simple habitat factors have been useful in the past for explaining longitudinal variation in the Red River resident trout populations. Depth parameters were positively correlated with resident trout biomass in 2006 and 2007, but this variable was confounded by the fact that most of the deeper habitats were located in the larger, downstream reach of the Red River, relatively far away from the hydrothermal scars and the sediment plume. Depth parameters were not strongly correlated with biomass in 2008, likely because mean depth, mean maximum depth, and residual pool depth were similar among sites, because the sites had been filled in with sediment. In 2009, the habitat quality rating and percentage of pool habitat were positively correlated with fish density, while the percentage of run habitat was positively correlated with fish biomass. However, in 2006, 2007, and 2009 all three of these variables were generally greater in the larger, downstream reach of the Red River, which is furthest away from the hydrothermal scars.

In 2010, the habitat quality index rating was positively correlated with biomass ($r = 0.62$; $p < 0.05$), while the percent embeddedness and percent riffle embeddedness metrics were negatively correlated with density ($r = -0.69$ and -0.81, respectively; $p < 0.05$). These results in 2010 indicate that biomass is regulated by the quality of the habitat, which may include substrate characteristics, the presence of pools, and the presence of cover, while density is regulated more by embeddedness characteristics, which would influence YOY recruitment and survival. Contrary to recent years, the habitat quality index was not skewed with higher values at downstream sites, furthest away from the hydrothermal scars. Instead, high habitat quality index and biomass values occurred at both upstream and downstream sites.

5.4.1.5 Barriers to Fish Migration

Recolonization of the Red River by fish is limited by fragmentation in the watershed caused by barriers. Two diversions, one below the Questa Ranger Station, and the other upstream of the NMDGF fish hatchery (but downstream of the Upstream of Hatchery sampling site) are barriers to upstream migration of fish. Therefore, immigrants into the Red River study area reach must come from upstream reaches and tributaries such as Columbine and Cabresto creeks. Previous investigations of these upstream reaches have revealed robust fish populations (GEI 2006). However, the smaller size of the upstream reaches and tributaries and the lack of a downstream source of immigrants will limit the rate at which the resident brown trout population becomes reestablished following major disturbances, such as the mudslides in 2007.

5.4.1.6 Winter Conditions

Spring and fall benthic invertebrate data are available since 2000. Analysis of these data indicates frequently lower benthic invertebrate metric values in spring than in the previous fall. The overall means for the 2000 to 2010 time-period for density, number of taxa, and mayfly abundance were lower in spring than in fall at 9, 7, and 10 of the 11 sites, respectively. The 2000 to 2010 mean number of EPT taxa and mean metal intolerant taxa was lower in spring than in fall at 6 of the 11 sites for each metric. These results suggest harsh winter condition may be limiting the benthic invertebrate population in the Red River. However, spring benthic invertebrate metric values were not always less than values from the previous fall, indicating that harsh winter conditions may be a limiting factor in some years but not others.

6.0 Historical and Recent Trends in Aquatic Biota

6.1 Reach Descriptions

The available historical and recent fish and benthic invertebrate information was segmented into six reaches of the Red River, as previously described (Figure 1). These reaches were used to group data from multiple historical sampling sites into distinct, biologically significant parts of the river, which contain roughly similar characteristics of channel morphology, habitat, potential impacts, etc. This allowed for a more focused interpretation of the historical data.

6.2 Fish

Fish density data are available from three different time-periods of mine operation; 1) prior to the initiation of open pit mining, representing baseline data (1960 data), 2) during the intervening period of open pit and underground mine operation (1974-1988 data), and 3) present conditions represented by late summer and fall data collected from 1997 through 2010 by GEI and NMDGF. As previously described, only first-pass electrofishing density data were used, since this was the primary sampling method used during the earlier studies. In addition, since rainbow trout populations are maintained by stocking, they have been omitted from the comparison.

The longitudinal trends in fish density (number of fish/mile) were similar during all three time-periods (Figure 19). The trends all indicate relatively high fish density upstream of the Town of Red River, decreasing density downstream of the Town of Red River and downstream of Hansen Creek, and increasing density downstream of Cabresto Creek (Figure 19). This trend holds for baseline conditions (1960 data), during the intervening period of open pit and underground mine operation (1974-1988 data), and present conditions (1997-2010 data). These are the same trends identified in our earlier reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; Chadwick et al. 2005; GEI 2006, 2008, 2009, 2010).

The trends in trout density in all three periods indicate that reductions in density, reflecting the decreased suitability of the Red River to support trout, first occur near the Town of Red River. The trends in trout density in all three periods also indicate further impacts to trout downstream of Hansen Creek (Figure 19). Downstream of Hansen Creek and through the reach of the Red River adjacent to the Questa Mine property, trout density exhibited some recovery during all three time-periods, but remained low. Trout density was also low in the reach from Capulin Canyon to Cabresto Creek. During all three sampling periods, there was also a substantial increase in resident trout density in the reach of the Red River downstream of Cabresto Creek. In this lower reach of the river, trout density returned to levels comparable to or higher than those found in the reach upstream of the Town of Red River.

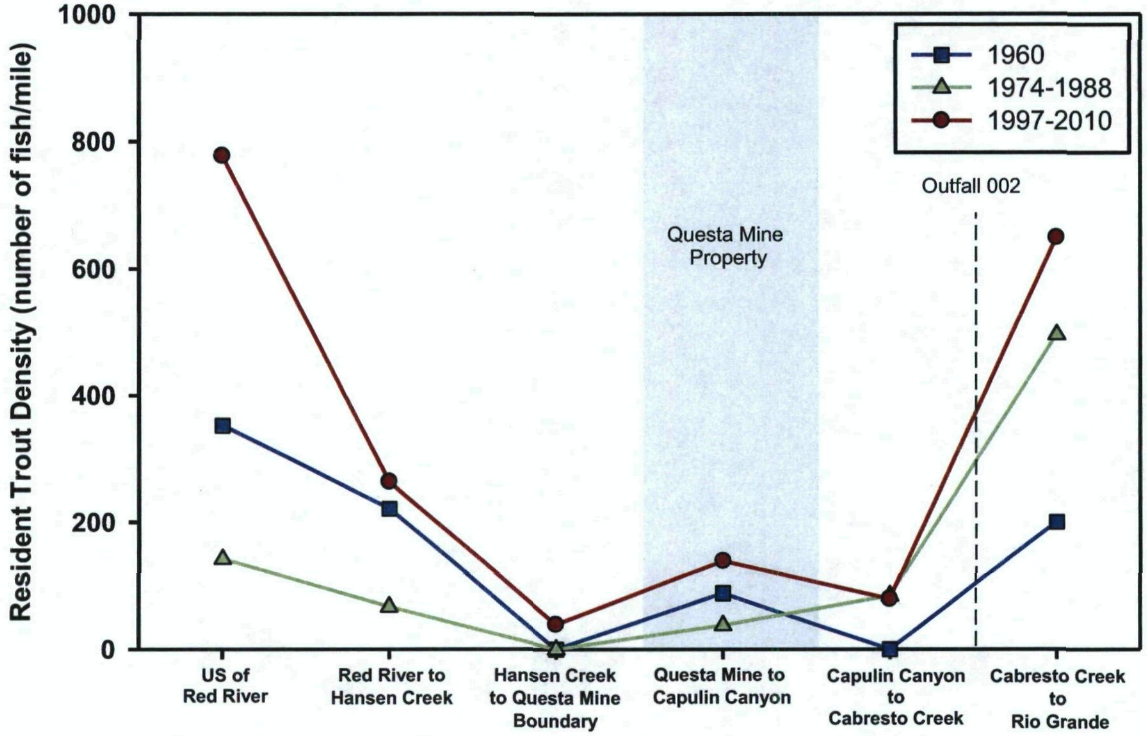


Figure 19: Longitudinal trends in resident trout density (#/mile) for baseline conditions (1960), open pit and underground mine operation (1974-1988), and present conditions (1997-2010). First pass electrofishing data only.

In all reaches, fish density is similar to or higher in the present time-period (1997-2010) than during the baseline period (1960) and the open pit and underground mining period (1974-1988). As mentioned previously, this may be due to differences in the methods and efficiency of collecting fish (CEC 2005c). However, these data suggest the Red River supported at least as many fish during recent years as it did prior to open pit mining.

6.3 Benthic Invertebrates

For benthic invertebrates, the data were also divided into three time-periods as previously described; 1) baseline conditions were represented by data collected in 1965, 2) the intervening period (1970-1992) representing conditions during open pit and underground mining, and 3) data collected in 1995 through fall 2010 representing present conditions. Comparisons were made between periods for density (#/m^2) and number of taxa.

The longitudinal trends in benthic invertebrate density for the three sampling periods (1965, 1970-1992, and 1995-2010) demonstrate a pattern similar to fish density (Figure 20), with decreasing density from upstream of the Town of Red River to Hansen Creek and lower densities of benthic invertebrates downstream of Hansen Creek (Figure 20).

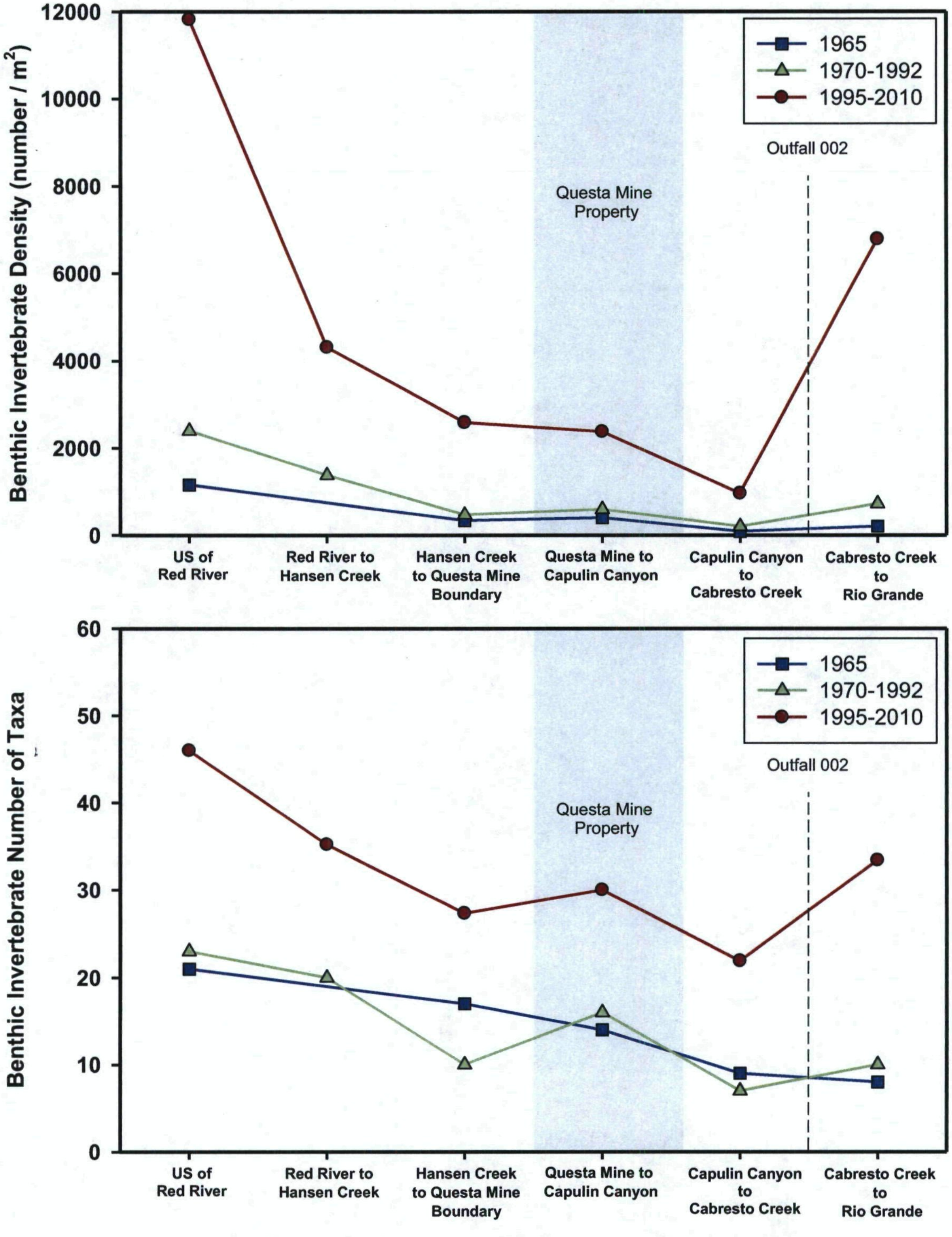


Figure 20: Longitudinal trends in benthic invertebrate density (top) and number of taxa (bottom) for baseline conditions (1965 data), open pit and underground mine operation (1970–1992 data), and present conditions (1995–2010 data).

In the remainder of the Red River from the Questa Mine property downstream past Cabresto Creek, the data from the three sampling periods also have a trend similar to the fish data (Figures 19 and 20). Low densities of invertebrates continue to occur adjacent to the Questa Mine, and the lowest densities are found near the Questa Ranger Station in the reach of the river downstream of Capulin Canyon. This is followed by an increase in density in the reach downstream of Questa, after Cabresto Creek inputs relatively clean water into the Red River. This general trend has become more pronounced since 1965.

The trend in the number of taxa for the three sampling periods (1965, 1970-1992, and 1995-2010) indicates a gradual decrease in taxa along the length of the Red River to the reach downstream of Capulin Canyon (Figure 20). This is followed by an increase in number of taxa downstream of Cabresto Creek for the two most recent periods (1970-1992 and 1995-2010), but this increase was not observed in the baseline period.

In all six reaches, densities and numbers of taxa are substantially higher for data collected in 1995 through 2010 than during the baseline period and the period of open pit and underground mine operation (Figure 20). As mentioned earlier, this may be in part due to different methods of data collection and analysis (CEC 2005c). However, these data suggest that the Red River is at least as suitable for sustaining benthic invertebrates in recent years as it was prior to the initiation of open pit mine operations.

7.0 Conclusions

7.1 Fish Populations

Resident trout populations from 1997 through 2009 indicated that there were three areas of impact resulting in decreases in trout abundance. These areas are 1) downstream of the Town of Red River, 2) downstream of Hansen Creek, and 3) downstream of Capulin Canyon. The impacted trout populations in these areas are primarily the result of poor water quality and sediment input from hydrothermal scars and upwelling groundwater. Two of these three reaches were identified as areas of impact to the fish populations in the Red River in 2010; however, impacts were not as evident as in the past in the reach immediately downstream of the Town of Red River.

Resident brown trout were collected at all eleven sites in the Red River in 2010. Brown trout were more abundant than hatchery stocked rainbow trout at six of the eleven sites and at all sites combined. Resident trout biomass was relatively high at most sites compared to recent years; however, the biomass at each site was still less than the average biomass of 69 lbs/acre in the Rocky Mountain Forest ecoregion. Young of the year, juvenile, and adult brown trout were collected at all sites, except the Downstream of Hansen and Upstream of Columbine sites, where only juvenile or adults were collected. The presence of multiple age classes of brown trout at most sites, indicates that the Red River supported a more balanced population within the study area in 2010 than in recent years. The low resident trout biomass and density levels, and the lack of or limited number of individuals in some age classes in reaches immediately upstream of the mine property and near the downstream boundary of the mine property, indicates that the resident trout population continues to appear stressed in these reaches.

Resident trout density and biomass in 2010 was greater than or equal to values observed in 2007, 2008, and 2009 at 10 of the 11 monitoring sites. Although the resident trout population has increased the last few years, the population has not yet completely recovered to levels seen in 2006, prior to the 2007 Hot-n-Tot Creek mudslides, as the biomass and density levels in 2010 were less than levels in 2006 at most sites. However, resident trout density and biomass, while less than in 2006, has recovered to levels similar to in many of the years prior to the 2007 mudslides.

Fish population data from three different time-periods of mine operation were assessed and include 1) prior to the initiation of open pit mining, representing baseline data (1960), 2) during the intervening period of open pit and underground mine operation (1974-1988), and 3) present conditions represented by late summer and fall data collected from 1997 through 2010. All three time-periods indicate similar longitudinal trends, with reduced resident trout density reflecting the decreased suitability of the Red River to support trout, first occurring near the Town of Red River. The trends also indicate further impacts to trout downstream of Hansen Creek. Some recovery in trout density occurred in the reach adjacent to the Questa Mine property, but density levels remained low. Trout density decreased again downstream of Capulin Canyon in two of the three time-periods. During all three sampling periods, there was a substantial increase in resident trout density in the reach of the Red River downstream of Cabresto Creek. In this lower reach of the river, trout density returned to levels comparable to or higher than those found in the reach upstream of the Town of Red River.

7.2 Habitat

Habitat characteristics were often similar among sites in 2010; however, some longitudinal trends were identified. Depth parameters were similar among most sites, but maximum depths occurred at the Upstream of Hatchery Site. The mean residual pool depth was lowest at the Downstream of Hansen Site, resulting in a decreased quality of refuge areas for fish during low flow and winter conditions compared to the other sites. Habitat quality ratings varied from a low of 2.2 at the Downstream of Hansen Site to a high of 3.4 at the Elephant Rock Site. The low habitat quality rating at the Downstream of Hansen Site was in part related to the low residual pool depths present at this site. Most sites were dominated by riffle habitat in terms of total area, but run habitat was more prevalent at downstream sites. Sediment indices were relatively low at most sites in spring and fall 2010 compared to recent years, with the highest values occurring at the Elephant Rock and Downstream of Hansen Creek sites. The fine sediment and embeddedness metric values in spring and fall 2010 were less than in fall 2006, prior to the 2007 mudslides at most sites. It appears the high flows in 2008, 2009, and 2010 have been sufficient to remove the excess sediment introduced from the summer 2007 mudslides out of the study reach, resulting in substrate characteristics in 2010 that were similar to fall 2006 at most sites.

Substrate embeddedness was highly variable from 2002 through 2010 at the six upstream most sites on the Red River and was generally similar at the downstream sites, except in 2007 when it was high at most sites from the Hot-n-Tot Creek mudslides. A combination of increased sedimentation and decreased water quality from periodic mudslides appears to be a major factor that limits the resident trout population in the Red River over time. Drought and the lack of sizeable spring runoff flows appeared to exacerbate the problem of high sedimentation levels during some years whereas high spring runoff flows following the 2007 mudslides resulted in a substantial reduction in embeddedness levels and substantial recovery in the resident trout population by 2010.

7.3 Benthic Invertebrate Populations

The patterns in benthic invertebrate parameters in past years suggest three areas of impact to the Red River, similar to the trends for fish data. The reaches of the river downstream of the Town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon consistently indicate lower density of invertebrates. All reaches of the Red River support at least some sensitive species of invertebrates during spring and fall sampling, indicating that although sedimentation and/or poor water quality may be affecting the benthic invertebrate population the water quality is sufficient to maintain at least some of the more sensitive species at all sites.

In spring 2010, most metric values at sites adjacent to or downstream of the mine were statistically similar to or greater than mean values at the upstream reference sites. The only exceptions were for number of taxa and density, with the mean number of taxa at the Questa Ranger Station Site significantly lower than the reference site mean and density values significantly lower than the reference site mean at the Downstream of Cabin Springs, Goathill, and Questa Ranger Station sites. These results indicate that the benthic invertebrate communities in spring at sites adjacent to or downstream of the mine were at least as healthy or in many cases healthier than the overall mean upstream reference site.

In fall 2010, the Downstream of Highway 522 and the Upstream of Hatchery sites had mean metric values that were either significantly greater than or not significantly different from the reference site mean values. The remaining sites had at least one mean metric value that was significantly less than the reference site mean values. The percent of EPT taxa, percent density of mayflies, and percent density of heptageniid mayflies were not significantly different or were significantly greater at each of the sites adjacent to or downstream of the mine than the mean metric values for the reference sites. However, the number of metal intolerant taxa metric was significantly less than the reference site mean at the Questa Ranger Station, Upstream of Highway 522, and Downstream of Outfall 002 sites. The Questa Ranger Station Site had a number of metrics that were significantly lower than the reference site mean including density, number of taxa, number of EPT taxa, and number of metal intolerant taxa. Overall, these results indicate that the benthic invertebrate community in fall at sites adjacent to and downstream of the mine was in many cases as healthy as the overall mean upstream reference site, with the exception of the stressed benthic invertebrate community observed at the Questa Ranger Station Site.

In 2010, most metric values in spring were less than in fall for a given site. The number of sites where spring values were less than fall values for density, total number of taxa, number of EPT taxa, percent EPT taxa, percent density of mayflies, number of metal intolerant taxa, and diversity metrics ranged from seven to nine sites. The percent density of heptageniid mayflies was lower in spring than in fall at 6 of 11 sites. The overall lower metric values in spring than in fall suggest harsh over-winter conditions and improved summer conditions in the Red River.

At all sites along the river, including those in the most impacted reaches, at least some of the more sensitive EPT taxa were present. Heptageniid mayflies, which are especially sensitive to higher metal concentrations, were present at 10 of the 11 sites in spring and all sites in fall 2010. Heptageniid mayfly density was lowest at the four upstream most sites, which includes the reference sites in both spring and fall. Metal intolerant taxa were detected at all sites in both spring and fall, with the fewest metal intolerant taxa present at the Upstream of Highway 522 Site in spring and at the Questa Ranger Station and Downstream of Outfall 002 sites in fall. The presence of metal intolerant taxa at all sites in the Red River indicates that the water quality is suitable to sustain at least some of the more sensitive metal intolerant species at each site.

7.4 Trends

Our previous reports (CEC 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005a, b; GEI 2006, 2008, 2009, 2010) concluded that the primary impacts to the suitability of the Red River to sustain aquatic biota were occurring just downstream of the Town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon. These three areas all have surface water and/or groundwater connections to the Red River in the area of natural hydrothermal scars. Downstream of the confluence of Cabresto Creek, conditions improved for both fish and benthic invertebrates.

These impacts in the Red River appear to be resulting from the input of excess sediment from a number of sources and decreased water quality, especially at locations receiving drainage from hydrothermal scars. Our previous reports further concluded that baseline data indicated these impacts were present prior to the initiation of open pit mining at the CMI Questa Mine, and in reaches of the Red River upstream of the mine. Overall, the data from 2010 support these conclusions from our previous reports; however, the aquatic community at the June Bug Site did not indicate as much of an impact from the Town of Red River as seen in the recent and historical data. Aquatic biological data from 2010 demonstrate recovery from the 2007 mudslides to levels similar to those observed in many of the recent years since 1997, but not to levels documented in 2006 for fish.

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Appendix A

Fish Data 2010

CMI
09/30/10
JUNE BUG

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRK	145	30.5	1.00	31.0	98.2
1	BRK	85	5.5	0.90		
1	BRN	252	162	1.01	174.2	93.0
1	BRN	224	112	1.00	123.0	91.1
1	BRN	205	90	1.04	94.6	95.2
1	BRN	202	72	0.87	90.5	79.5
1	BRN	195	72	0.97	81.6	88.3
1	BRN	189	72	1.07	74.4	96.8
1	BRN	187	66	1.01	72.1	91.6
1	BRN	185	60	0.95	69.8	86.0
1	BRN	180	68	1.17	64.4	105.7
1	BRN	178	50	0.89	62.3	80.3
1	BRN	175	52	0.97	59.2	87.8
1	BRN	162	43	1.01	47.1	91.3
1	BRN	156	26	0.68	42.1	61.7
1	BRN	155	45	1.21	41.3	108.9
1	BRN	155	42	1.13	41.3	101.6
1	BRN	150	36	1.07	37.5	96.0
1	BRN	149	34	1.03	36.8	92.4
1	BRN	149	28	0.85	36.8	76.1
1	BRN	144	28	0.94	33.2	84.2
1	BRN	140	42	1.53	30.6	137.3
1	BRN	135	22	0.89		
1	BRN	135	21	0.85		
1	BRN	131	23	1.02		
1	BRN	129	20.5	0.95		
1	BRN	120	16	0.93		
1	BRN	120	15.5	0.90		
1	BRN	116	15.5	0.99		
1	BRN	115	16	1.05		
1	BRN	115	15	0.99		
1	BRN	95	7.8	0.91		
1	BRN	81	5.3	1.00		
1	BRN	72	3.8	1.02		
1	BRN	67	3.0	1.00		
1	BRN	65	2.6	0.95		
1	BRN	56	1.5	0.85		
1	BRN	55	0.7	0.42		
1	HYB	65	1.0	0.36		
1	HYB	44	0.4	0.47		
1	HYB	40	0.1	0.16		
1	RBT	400	800	1.25	700.9	114.1
1	RBT	282	214	0.95	243.5	87.9
1	RBT	275	212	1.02	225.7	93.9
1	RBT	260	192	1.09	190.5	100.8
1	RBT	249	150	0.97	167.2	89.7

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	236	140	1.07	142.1	98.5
1	RBT	219	108	1.03	113.4	95.3
1	RBT	195	90	1.21	79.8	112.8
1	RBT	195	74	1.00	79.8	92.7
2	BRN	210	84	0.91	101.6	82.7
2	BRN	179	46	0.80	63.3	72.7
2	BRN	149	32	0.97	36.8	87.0
2	BRN	140	29	1.06	30.6	94.8
2	BRN	115	16	1.05		
2	BRN	71	3.3	0.92		
2	BRN	64	2.4	0.92		
2	HYB	41	0.5	0.73		
2	HYB	35	0.3	0.70		
2	RBT	265	160	0.86	201.8	79.3
2	RBT	234	118	0.92	138.5	85.2

SUMMARY:

BRK		LENGTH	WEIGHT	K	Wr
	N:	2	2	2	1
	MIN:	85	5.5	0.90	98.2
	MAX:	145	30.5	1.00	98.2
	MEAN:	115.0	18.0	0.95	98.2

BRN		LENGTH	WEIGHT	K	Wr
	N:	43	43	43	24
	MIN:	55	0.7	0.42	61.7
	MAX:	252	162	1.53	137.3
	MEAN:	141.1	37.3	0.97	90.9

HYB		LENGTH	WEIGHT	K	Wr
	N:	5	5	5	N/A
	MIN:	35	0.1	0.16	N/A
	MAX:	65	1.0	0.73	N/A
	MEAN:	45.0	0.5	0.48	N/A

RBT		LENGTH	WEIGHT	K	Wr
	N:	11	11	11	11
	MIN:	195	74	0.86	79.3
	MAX:	400	800	1.25	114.1
	MEAN:	255.5	205.3	1.03	95.5

SUMMARY (cont.) :

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRK	2	0	2	±	0.0	0.135	15	±	0.0	0.60
BRN	36	7	44	±	3.3	0.135	326	±	24.4	26.81
HYB	3	2	5	±	3.3	0.135	37	±	24.4	0.04
RBT	9	2	11	±	1.6	0.135	81	±	11.9	36.66

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRK	2	0	2	±	0.0	0.055	36	±	0.0	0.65
BRN	36	7	44	±	3.3	0.055	800	±	60.0	29.84
HYB	3	2	5	±	3.3	0.055	91	±	60.0	0.05
RBT	9	2	11	±	1.6	0.055	200	±	29.1	41.06

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRK	2	0	2	±	0.0	0.061	33	±	0.0	1.31
BRN	36	7	44	±	3.3	0.061	721	±	54.1	59.29
HYB	3	2	5	±	3.3	0.061	82	±	54.1	0.09
RBT	9	2	11	±	1.6	0.061	180	±	26.2	81.47

CMI
9/27/2010
ELEPHANT ROCK

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRK	85	4.7	0.77		
1	BRN	299	254	0.95	289.1	87.9
1	BRN	290	254	1.04	264.1	96.2
1	BRN	243	140	0.98	156.5	89.5
1	BRN	235	118	0.91	141.7	83.3
1	BRN	225	107	0.94	124.6	85.9
1	BRN	218	94	0.91	113.5	82.9
1	BRN	201	68	0.84	89.2	76.2
1	BRN	194	72	0.99	80.3	89.6
1	BRN	190	68	0.99	75.5	90.0
1	BRN	164	58	1.31	48.9	118.7
1	BRN	155	34	0.91	41.3	82.2
1	BRN	138	25	0.95		
1	BRN	93	6.9	0.86		
1	BRN	91	6.7	0.89		
1	BRN	85	6.3	1.03		
1	BRN	85	5.8	0.94		
1	BRN	77	4.5	0.99		
1	RBT	325	400	1.17	374.1	106.9
1	RBT	315	320	1.02	340.3	94.0
1	RBT	295	260	1.01	279.1	93.2
1	RBT	285	225	0.97	251.4	89.5
1	RBT	275	190	0.91	225.7	84.2
1	RBT	268	170	0.88	208.8	81.4
1	RBT	264	173	0.94	199.5	86.7
1	RBT	259	162	0.93	188.3	86.0
1	RBT	235	112	0.86	140.3	79.8
1	RBT	230	148	1.22	131.5	112.6
1	RBT	225	112	0.98	123.0	91.0
1	RBT	200	70	0.88	86.2	81.2
1	RBT	195	90	1.21	79.8	112.8
1	RBT	195	72	0.97	79.8	90.2
1	RBT	175	50	0.93	57.5	86.9
1	WS	74	4.2	1.04		
2	BRN	241	142	1.01	152.7	93.0
2	BRN	213	93	0.96	105.9	87.8
2	BRN	211	78	0.83	103.0	75.7
2	BRN	210	93	1.00	101.6	91.6
2	BRN	197	70	0.92	84.1	83.3
2	BRN	170	47	0.96	54.3	86.5
2	BRN	71	3.1	0.87		
2	RBT	375	610	1.16	576.6	105.8
2	RBT	205	80	0.93	92.8	86.2

SUMMARY:

BRK		LENGTH	WEIGHT	K	Wr
	N:	1	1	1	N/A
	MIN:	85	4.7	0.77	N/A
	MAX:	85	4.7	0.77	N/A
	MEAN:	85.0	4.7	0.77	N/A

BRN		LENGTH	WEIGHT	K	Wr
	N:	24	24	24	17
	MIN:	71	3.1	0.83	75.7
	MAX:	299	254	1.31	118.7
	MEAN:	179.0	77.0	0.96	88.3

RBT		LENGTH	WEIGHT	K	Wr
	N:	17	17	17	17
	MIN:	175	50	0.86	79.8
	MAX:	375	610	1.22	112.8
	MEAN:	254.2	190.8	1.00	92.3

WS		LENGTH	WEIGHT	K	Wr
	N:	1	1	1	N/A
	MIN:	74	4.2	1.04	N/A
	MAX:	74	4.2	1.04	N/A
	MEAN:	74	4.2	1.04	N/A

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRK	1	0	1	±	0.0	0.160	6	±	0.0	0.06
BRN	17	7	26	±	6.7	0.160	163	±	41.9	27.67
RBT	15	2	17	±	1.1	0.160	106	±	6.9	44.59
WS	1	0	1	±	0.0	0.160	6	±	0.0	0.06

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRK	1	0	1	±	0.0	0.065	15	±	0.0	0.07
BRN	17	7	26	±	6.7	0.065	400	±	103.1	30.80
RBT	15	2	17	±	1.1	0.065	262	±	16.9	49.99
WS	1	0	1	±	0.0	0.065	15	±	0.0	0.06

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRK	1	0	1	±	0.0	0.062	16	±	0.0	0.17
BRN	17	7	26	±	6.7	0.062	419	±	108.1	71.13
RBT	15	2	17	±	1.1	0.062	274	±	17.7	115.25
WS	1	0	1	±	0.0	0.062	16	±	0.0	0.15

CMI
9/30/2010
DOWNSTREAM OF HANSEN

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	295	279	1.09	279.1	100.0
1	RBT	295	248	0.97	279.1	88.9
1	RBT	290	250	1.03	265.0	94.3
1	RBT	275	234	1.13	225.7	103.7
1	RBT	268	179	0.93	208.8	85.7
1	RBT	245	150	1.02	159.2	94.2
2	BRN	248	160	1.05	166.2	96.3
2	RBT	235	130	1.00	140.3	92.6

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	1	1	1	1
	MIN:	248	160	1.05	97.0
	MAX:	248	160	1.05	97.0
	MEAN:	248.0	160.0	1.05	97.0

RBT		LENGTH	WEIGHT	K	Wr
	N:	7	7	7	7
	MIN:	235	130	0.93	85.7
	MAX:	295	279	1.13	103.7
	MEAN:	271.9	210.0	1.02	94.2

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	0	1	1	±	--	0.136	7	±	--	2.47
RBT	6	1	7	±	1.1	0.136	51	±	8.1	23.61

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	0	1	1	±	--	0.055	18	±	--	2.88
RBT	6	1	7	±	1.1	0.055	127	±	20.0	26.67

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length (mile)	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	0	1	1	±	--	0.068	15	±	--	5.29
RBT	6	1	7	±	1.1	0.068	103	±	16.2	47.69

CMI
09/30/10
UPSTREAM OF COLUMBINE

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	229	120	1.00	131.3	91.4
1	BRN	228	122	1.03	129.6	94.2
1	BRN	155	38	1.02	41.3	91.9
1	HYB	333	400	1.08	424.7	94.2
1	HYB	41	0.4	0.58		
1	HYB	40	0.4	0.63		
1	RBT	320	310	0.95	356.9	86.9
1	RBT	318	305	0.95	350.2	87.1
1	RBT	309	271	0.92	321.1	84.4
1	RBT	284	242	1.06	248.8	97.3
1	RBT	283	242	1.07	246.2	98.3
2	BRN	208	95	1.06	98.7	96.2

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	4	4	4	4
	MIN:	155	38	1.00	91.4
	MAX:	229	122	1.06	96.2
	MEAN:	205.0	93.8	1.03	93.4

HYB		LENGTH	WEIGHT	K	Wr
	N:	3	3	3	1
	MIN:	40	0.4	0.58	94.2
	MAX:	333	400	1.08	94.2
	MEAN:	138.0	133.6	0.76	94.2

RBT		LENGTH	WEIGHT	K	Wr
	N:	5	5	5	5
	MIN:	283	242	0.92	84.4
	MAX:	320	310	1.07	98.3
	MEAN:	302.8	274.0	0.99	90.8

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area	Density		95% CI	Biomass
BRN	3	1	4	±	2.0	0.140	29	±	14.3	6.00
HYB	3	0	3	±	0.0	0.140	21	±	0.0	6.19
RBT	5	0	5	±	0.0	0.140	36	±	0.0	21.75

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area	Density		95% CI	Biomass
BRN	3	1	4	±	2.0	0.057	70	±	35.1	6.57
HYB	3	0	3	±	0.0	0.057	53	±	0.0	7.08
RBT	5	0	5	±	0.0	0.057	88	±	0.0	24.11

	1st Pass	2nd Pass	Pop Est		95% CI	Site	Density		95% CI	Biomass
BRN	3	1	4	±	2.0	0.069	58	±	29.0	11.99
HYB	3	0	3	±	0.0	0.069	43	±	0.0	12.66
RBT	5	0	5	±	0.0	0.069	72	±	0.0	43.49

CMI
09/30/10
DOWNSTREAM OF CABIN SPRINGS

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	278	225	1.05	233.0	96.6
1	BRN	254	145	0.88	178.4	81.3
1	BRN	241	130	0.93	152.7	85.1
1	BRN	240	115	0.83	150.8	76.3
1	BRN	235	105	0.81	141.7	74.1
1	BRN	227	105	0.90	127.9	82.1
1	BRN	224	105	0.93	123.0	85.4
1	BRN	214	70	0.71	107.4	65.2
1	BRN	201	60	0.74	89.2	67.2
1	BRN	200	70	0.88	87.9	79.6
1	BRN	147	29	0.91	35.3	82.1
1	BRN	138	21	0.80		
1	BRN	130	19	0.86		
1	BRN	121	16	0.90		
2	BRN	244	120	0.83	158.4	75.8
2	BRN	160	35	0.85	45.4	77.1
2	BRN	130	22	1.00		
2	BRN	105	10	0.86		
2	BRN	61	1.5	0.66		

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	19	19	19	13
	MIN:	61	1.5	0.66	65.2
	MAX:	278	225	1.05	96.6
	MEAN:	186.8	73.9	0.86	79.1

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	14	5	20	±	4.6	0.145	138	± 31.7	22.48

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)	95% CI	Biomass (kg/ha)
BRN	14	5	20	±	4.6	0.059	339	± 78.0	25.05

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	14	5	20	±	4.6	0.080	250	± 57.5	40.73

CMI
09/29/10
GOATHILL

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	266	160	0.85	204.5	78.2
1	BRN	260	186	1.06	191.1	97.3
1	BRN	194	63	0.86	80.3	78.4
1	BRN	165	41	0.91	49.7	82.4
1	BRN	141	26	0.93	31.2	83.2
1	BRN	81	3.8	0.72		
1	BRN	77	4.4	0.96		
1	RBT	235	104	0.80	140.3	74.1
2	BRN	239	112	0.82	149.0	75.2
2	BRN	170	47	0.96	54.3	86.5
2	BRN	91	5.7	0.76		

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	10	10	10	7
	MIN:	77	3.8	0.72	75.2
	MAX:	266	186	1.06	97.3
	MEAN:	168.4	64.9	0.88	83.0

RBT		LENGTH	WEIGHT	K	Wr
	N:	1	1	1	1
	MIN:	235	104	0.80	74.1
	MAX:	235	104	0.80	74.1
	MEAN:	235.0	104.0	0.80	74.1

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	7	3	10	±	2.7	0.183	55	±	14.8	7.87
RBT	1	0	1	±	0.0	0.183	5	±	0.0	1.15

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	7	3	10	±	2.7	0.074	135	±	36.5	8.76
RBT	1	0	1	±	0.0	0.074	14	±	0.0	1.46

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	7	3	10	±	2.7	0.077	130	±	35.1	18.60
RBT	1	0	1	±	0.0	0.077	13	±	0.0	2.98

CMI
09/28/10
QUESTA RANGER STATION

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	344	410	1.01	437.7	93.7
1	BRN	282	275	1.23	243.1	113.1
1	BRN	251	175	1.11	172.2	101.6
1	BRN	243	140	0.98	156.5	89.5
1	BRN	194	60	0.82	80.3	74.7
1	BRN	187	75	1.15	72.1	104.1
1	BRN	80	5.5	1.07		
1	BRN	69	3.3	1.00		
1	BRN	65	2.7	0.98		
1	BRN	44	0.9	1.06		
1	BRN	39	0.7	1.18		
1	RBT	346	420	1.01	452.0	92.9
1	RBT	311	340	1.13	327.4	103.8
1	RBT	294	260	1.02	276.2	94.1
1	RBT	289	225	0.93	262.3	85.8
1	RBT	279	205	0.94	235.8	86.9
2	BRN	48	1.3	1.18		

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	12	12	12	6
	MIN:	39	0.7	0.82	74.7
	MAX:	344	410	1.23	113.1
	MEAN:	153.8	95.8	1.06	96.1

RBT		LENGTH	WEIGHT	K	Wr
	N:	5	5	5	5
	MIN:	279	205	0.93	85.8
	MAX:	346	420	1.13	103.8
	MEAN:	303.8	290.0	1.01	92.7

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	11	1	12	±	0.7	0.168	71	±	4.2	15.00
RBT	5	0	5	±	0.0	0.168	30	±	0.0	19.18

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	11	1	12	±	0.7	0.068	176	±	10.3	16.86
RBT	5	0	5	±	0.0	0.068	74	±	0.0	21.46

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	11	1	12	±	0.7	0.069	174	±	10.1	36.75
RBT	5	0	5	±	0.0	0.069	72	±	0.0	46.03

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UPSTREAM OF HIGHWAY 522

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	277	235	1.11	230.5	101.9
1	BRN	247	160	1.06	164.2	97.4
1	BRN	241	150	1.07	152.7	98.2
1	BRN	239	148	1.08	149.0	99.4
1	BRN	236	110	0.84	143.5	76.7
1	BRN	198	70	0.90	85.3	82.0
1	BRN	191	65	0.93	76.7	84.7
1	BRN	190	67	0.98	75.5	88.7
1	BRN	189	68	1.01	74.4	91.4
1	BRN	187	65	0.99	72.1	90.2
1	BRN	187	64	0.98	72.1	88.8
1	BRN	187	56	0.86	72.1	77.7
1	BRN	184	63	1.01	68.7	91.7
1	BRN	184	59	0.95	68.7	85.9
1	BRN	177	42	0.76	61.2	68.6
1	BRN	175	51	0.95	59.2	86.1
1	BRN	171	47	0.94	55.3	85.0
1	BRN	170	47	0.96	54.3	86.5
1	BRN	161	35	0.84	46.3	75.7
1	BRN	105	10	0.86		
1	BRN	100	10.3	1.03		
1	BRN	96	8.6	0.97		
1	BRN	52	1.7	1.21		
1	HYB	175	58	1.08	57.8	100.3
1	HYB	148	34	1.05	34.4	98.8
1	RBT	347	415	0.99	456.0	91.0
1	RBT	312	315	1.04	330.6	95.3
1	RBT	299	250	0.94	290.7	86.0
1	RBT	294	203	0.80	276.2	73.5
1	RBT	292	250	1.00	270.6	92.4
1	RBT	291	222	0.90	267.8	82.9
1	RBT	281	210	0.95	240.9	87.2
1	RBT	275	218	1.05	225.7	96.6
1	RBT	273	214	1.05	220.8	96.9
1	RBT	273	186	0.91	220.8	84.2
1	RBT	273	180	0.88	220.8	81.5
1	RBT	268	230	1.19	208.8	110.2
1	RBT	268	204	1.06	208.8	97.7
1	RBT	266	210	1.12	204.1	102.9
1	RBT	266	200	1.06	204.1	98.0
1	RBT	264	180	0.98	199.5	90.2
1	RBT	262	168	0.93	195.0	86.2
1	RBT	261	168	0.94	192.7	87.2
1	RBT	259	178	1.02	188.3	94.5
1	RBT	256	138	0.82	181.8	75.9
1	RBT	255	160	0.96	179.6	89.1

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	254	174	1.06	177.5	98.0
1	RBT	253	154	0.95	175.4	87.8
1	RBT	251	130	0.82	171.2	75.9
1	RBT	246	150	1.01	161.1	93.1
1	RBT	242	151	1.07	153.3	98.5
1	RBT	242	135	0.95	153.3	88.0
1	RBT	241	142	1.01	151.4	93.8
1	RBT	240	130	0.94	149.5	86.9
1	RBT	240	120	0.87	149.5	80.2
1	RBT	239	142	1.04	147.7	96.2
1	RBT	238	124	0.92	145.8	85.0
1	RBT	236	152	1.16	142.1	106.9
1	RBT	235	122	0.94	140.3	86.9
1	RBT	225	92	0.81	123.0	74.8
1	RBT	222	108	0.99	118.1	91.4
1	RBT	212	94	0.99	102.8	91.5
1	RBT	212	82	0.86	102.8	79.8
1	RBT	211	78	0.83	101.3	77.0
1	RBT	209	78	0.85	98.4	79.2
1	RBT	207	92	1.04	95.6	96.2
1	RBT	197	71	0.93	82.3	86.3
1	RBT	184	54	0.87	67.0	80.6
1	RBT	136	38	1.51	26.8	141.6
2	BRN	374	545	1.04	560.7	97.2
2	BRN	200	76	0.95	87.9	86.4
2	BRN	196	72	0.96	82.8	86.9
2	BRN	76	5.3	1.21		
2	RBT	295	282	1.10	279.1	101.0
2	RBT	280	282	1.28	238.3	118.3
2	RBT	262	198	1.10	195.0	101.6
2	RBT	232	132	1.06	135.0	97.8

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	27	27	27	22
	MIN:	52	1.7	0.76	68.6
	MAX:	374	545	1.21	101.9
	MEAN:	184.8	86.3	0.98	87.6

HYB		LENGTH	WEIGHT	K	Wr
	N:	2	2	2	2
	MIN:	148	34	1.05	98.8
	MAX:	175	58	1.08	100.3
	MEAN:	161.5	46.0	1.07	99.6

SUMMARY (cont.) :

RBT		LENGTH	WEIGHT	K	Wr
	N:	48	48	48	48
	MIN:	136	38	0.80	73.5
	MAX:	347	415	1.51	141.6
	MEAN:	251.6	166.8	0.99	91.5

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	23	4	27	±	1.8	0.187	144	±	9.6	27.40
HYB	2	0	2	±	0.0	0.187	11	±	0.0	1.12
RBT	44	4	48	±	1.3	0.187	257	±	7.0	94.51

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	23	4	27	±	1.8	0.076	355	±	23.7	30.64
HYB	2	0	2	±	0.0	0.076	26	±	0.0	1.20
RBT	44	4	48	±	1.3	0.076	632	±	17.1	105.42

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	23	4	27	±	1.8	0.083	325	±	21.7	61.83
HYB	2	0	2	±	0.0	0.083	24	±	0.0	2.43
RBT	44	4	48	±	1.3	0.083	578	±	15.7	212.55

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DOWNSTREAM OF HIGHWAY 522

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	280	205	0.93	238.0	86.1
1	BRN	260	172	0.98	191.1	90.0
1	BRN	247	147	0.98	164.2	89.5
1	BRN	240	148	1.07	150.8	98.1
1	BRN	235	116	0.89	141.7	81.9
1	BRN	220	114	1.07	116.6	97.8
1	BRN	218	107	1.03	113.5	94.3
1	BRN	210	88	0.95	101.6	86.6
1	BRN	205	92	1.07	94.6	97.3
1	BRN	205	84	0.98	94.6	88.8
1	BRN	200	78	0.98	87.9	88.7
1	BRN	200	78	0.98	87.9	88.7
1	BRN	200	70	0.88	87.9	79.6
1	BRN	195	72	0.97	81.6	88.3
1	BRN	195	70	0.94	81.6	85.8
1	BRN	180	62	1.06	64.4	96.3
1	BRN	175	52	0.97	59.2	87.8
1	BRN	120	18	1.04		
1	BRN	115	15	0.99		
1	BRN	111	13	0.95		
1	BRN	110	14	1.05		
1	BRN	110	13	0.98		
1	BRN	109	13	1.00		
1	BRN	105	11	0.95		
1	BRN	105	11	0.95		
1	BRN	95	9.0	1.05		
1	BRN	85	5.2	0.85		
1	BRN	83	5.5	0.96		
1	HYB	175	50	0.93	57.8	86.5
1	RBT	320	290	0.89	356.9	81.3
1	RBT	312	310	1.02	330.6	93.8
1	RBT	295	250	0.97	279.1	89.6
1	RBT	295	244	0.95	279.1	87.4
1	RBT	293	244	0.97	273.4	89.2
1	RBT	285	210	0.91	251.4	83.5
1	RBT	280	220	1.00	238.3	92.3
1	RBT	280	202	0.92	238.3	84.8
1	RBT	280	160	0.73	238.3	67.1
1	RBT	275	205	0.99	225.7	90.8
1	RBT	275	197	0.95	225.7	87.3
1	RBT	270	180	0.91	213.5	84.3
1	RBT	270	175	0.89	213.5	82.0
1	RBT	265	184	0.99	201.8	91.2
1	RBT	260	183	1.04	190.5	96.1
1	RBT	252	170	1.06	173.3	98.1
1	RBT	250	154	0.99	169.2	91.0

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	250	152	0.97	169.2	89.8
1	RBT	250	138	0.88	169.2	81.6
1	RBT	248	153	1.00	165.1	92.7
1	RBT	245	140	0.95	159.2	88.0
1	RBT	245	138	0.94	159.2	86.7
1	RBT	235	120	0.92	140.3	85.5
1	RBT	230	104	0.85	131.5	79.1
1	RBT	225	92	0.81	123.0	74.8
1	RBT	222	120	1.10	118.1	101.6
1	RBT	210	90	0.97	99.9	90.1
1	RBT	203	82	0.98	90.1	91.0
1	RBT	198	78	1.00	83.6	93.3
1	RBT	170	52	1.06	52.7	98.7
1	RBT	160	46	1.12	43.9	104.8
2	BRN	100	9.8	0.98		
2	BRN	97	9.2	1.01		
2	BRN	89	5.9	0.84		
2	RBT	260	165	0.94	190.5	86.6
2	RBT	254	148	0.90	177.5	83.4
2	RBT	240	130	0.94	149.5	86.9
2	RBT	204	90	1.06	91.5	98.4
2	RBT	182	68	1.13	64.8	105.0

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	31	31	31	17
	MIN:	83	5.2	0.84	79.6
	MAX:	280	205	1.07	98.1
	MEAN:	164.5	61.5	0.98	89.7

HYB		LENGTH	WEIGHT	K	Wr
	N:	1	1	1	1
	MIN:	175	50	0.93	86.5
	MAX:	175	50	0.93	86.5
	MEAN:	175.0	50.0	0.93	86.5

RBT		LENGTH	WEIGHT	K	Wr
	N:	36	36	36	36
	MIN:	160	46	0.73	67.1
	MAX:	320	310	1.13	105.0
	MEAN:	249.7	157.9	0.96	89.1

SUMMARY (cont.):

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	28	3	31	±	1.2	0.199	156	±	6.0	21.15
HYB	1	0	1	±	0.0	0.199	5	±	0.0	0.55
RBT	31	5	36	±	1.9	0.199	181	±	9.5	63.01

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	28	3	31	±	1.2	0.081	383	±	14.8	23.55
HYB	1	0	1	±	0.0	0.081	12	±	0.0	0.60
RBT	31	5	36	±	1.9	0.081	444	±	23.5	70.11

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	28	3	31	±	1.2	0.065	477	±	18.5	64.67
HYB	1	0	1	±	0.0	0.065	15	±	0.0	1.65
RBT	31	5	36	±	1.9	0.065	554	±	29.2	192.85

CMI
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DOWNSTREAM OF OUTFALL 002

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	312	300	0.99	327.9	91.5
1	BRN	308	340	1.16	315.6	107.7
1	BRN	299	275	1.03	289.1	95.1
1	BRN	281	195	0.88	240.5	81.1
1	BRN	279	205	0.94	235.5	87.0
1	BRN	270	210	1.07	213.7	98.3
1	BRN	257	180	1.06	184.7	97.5
1	BRN	254	180	1.10	178.4	100.9
1	BRN	227	125	1.07	127.9	97.7
1	BRN	221	105	0.97	118.1	88.9
1	BRN	210	100	1.08	101.6	98.5
1	BRN	208	90	1.00	98.7	91.2
1	BRN	208	85	0.94	98.7	86.1
1	BRN	208	80	0.89	98.7	81.0
1	BRN	202	75	0.91	90.5	82.8
1	BRN	200	80	1.00	87.9	91.0
1	BRN	198	65	0.84	85.3	76.2
1	BRN	195	70	0.94	81.6	85.8
1	BRN	193	70	0.97	79.1	88.5
1	BRN	187	70	1.07	72.1	97.2
1	BRN	174	55	1.04	58.2	94.5
1	BRN	164	45	1.02	48.9	92.1
1	BRN	128	20	0.95		
1	BRN	126	18	0.90		
1	BRN	124	19	1.00		
1	BRN	119	15	0.89		
1	BRN	116	17	1.09		
1	BRN	116	16	1.03		
1	BRN	112	15	1.07		
1	BRN	112	12	0.85		
1	BRN	110	13	0.98		
1	BRN	108	12	0.95		
1	BRN	108	11	0.87		
1	BRN	105	12	1.04		
1	BRN	103	11	1.01		
1	BRN	102	9.0	0.85		
1	BRN	100	10	1.00		
1	BRN	99	11	1.13		
1	BRN	98	9.0	0.96		
1	BRN	88	7.5	1.10		
1	BRN	87	6.5	0.99		
1	BRN	85	6.5	1.06		
1	HYB	200	100	1.25	87.5	114.3
1	HYB	185	70	1.11	68.7	101.9
1	RBT	350	440	1.03	468.0	94.0
1	RBT	335	410	1.09	410.0	100.0

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	328	380	1.08	384.6	98.8
1	RBT	324	420	1.23	370.6	113.3
1	RBT	318	300	0.93	350.2	85.7
1	RBT	316	320	1.01	343.6	93.1
1	RBT	308	280	0.96	318.0	88.1
1	RBT	298	280	1.06	287.8	97.3
1	RBT	297	265	1.01	284.8	93.0
1	RBT	297	250	0.95	284.8	87.8
1	RBT	295	245	0.95	279.1	87.8
1	RBT	295	215	0.84	279.1	77.0
1	RBT	293	255	1.01	273.4	93.3
1	RBT	290	225	0.92	265.0	84.9
1	RBT	288	240	1.00	259.5	92.5
1	RBT	288	240	1.00	259.5	92.5
1	RBT	286	255	1.09	254.1	100.3
1	RBT	284	225	0.98	248.8	90.4
1	RBT	283	225	0.99	246.2	91.4
1	RBT	281	240	1.08	240.9	99.6
1	RBT	281	230	1.04	240.9	95.5
1	RBT	281	220	0.99	240.9	91.3
1	RBT	279	205	0.94	235.8	86.9
1	RBT	278	235	1.09	233.2	100.8
1	RBT	276	235	1.12	228.2	103.0
1	RBT	276	210	1.00	228.2	92.0
1	RBT	275	250	1.20	225.7	110.8
1	RBT	274	210	1.02	223.2	94.1
1	RBT	272	205	1.02	218.3	93.9
1	RBT	272	200	0.99	218.3	91.6
1	RBT	271	210	1.06	215.9	97.3
1	RBT	268	200	1.04	208.8	95.8
1	RBT	268	165	0.86	208.8	79.0
1	RBT	267	220	1.16	206.4	106.6
1	RBT	267	210	1.10	206.4	101.7
1	RBT	267	195	1.02	206.4	94.5
1	RBT	263	170	0.93	197.2	86.2
1	RBT	262	180	1.00	195.0	92.3
1	RBT	262	180	1.00	195.0	92.3
1	RBT	261	195	1.10	192.7	101.2
1	RBT	261	175	0.98	192.7	90.8
1	RBT	257	140	0.82	183.9	76.1
1	RBT	255	185	1.12	179.6	103.0
1	RBT	254	155	0.95	177.5	87.3
1	RBT	254	155	0.95	177.5	87.3
1	RBT	254	150	0.92	177.5	84.5
1	RBT	250	145	0.93	169.2	85.7
1	RBT	250	135	0.86	169.2	79.8
1	RBT	248	150	0.98	165.1	90.8
1	RBT	248	145	0.95	165.1	87.8
1	RBT	247	160	1.06	163.1	98.1
1	RBT	247	145	0.96	163.1	88.9

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	246	160	1.07	161.1	99.3
1	RBT	243	130	0.91	155.3	83.7
1	RBT	235	120	0.92	140.3	85.5
1	RBT	235	115	0.89	140.3	82.0
1	RBT	232	125	1.00	135.0	92.6
1	RBT	232	115	0.92	135.0	85.2
1	RBT	231	115	0.93	133.2	86.3
1	RBT	229	214	1.78	129.8	164.9
1	RBT	228	130	1.10	128.1	101.5
1	RBT	216	90	0.89	108.7	82.8
1	RBT	195	95	1.28	79.8	119.0
2	BRN	346	410	0.99	445.3	92.1
2	BRN	316	320	1.01	340.5	94.0
2	BRN	204	75	0.88	93.2	80.5
2	BRN	201	85	1.05	89.2	95.3
2	BRN	199	80	1.02	86.6	92.4
2	BRN	192	80	1.13	77.9	102.7
2	BRN	108	13	1.03		
2	BRN	107	13	1.06		
2	BRN	102	10	0.94		
2	HYB	194	70	0.96	79.6	87.9
2	HYB	184	70	1.12	67.6	103.6
2	RBT	335	340	0.90	410.0	82.9
2	RBT	298	288	1.09	287.8	100.1
2	RBT	231	105	0.85	133.2	78.8
2	RBT	230	110	0.90	131.5	83.7

SUMMARY:

BRN		LENGTH	WEIGHT		K	Wr
	N:	51	51	0	51	28
	MIN:	85	6.5	0	0.84	76.2
	MAX:	346	410	0	1.16	107.7
	MEAN:	176.0	85.0	#	1.00	91.7

HYB		LENGTH	WEIGHT		K	Wr
	N:	4	4	0	4	4
	MIN:	184	70	0	0.96	87.9
	MAX:	200	100	0	1.25	114.3
	MEAN:	190.8	77.5	#	1.11	101.9

RBT		LENGTH	WEIGHT		K	Wr
	N:	67	67	0	67	67
	MIN:	195	90	0	0.82	76.1
	MAX:	350	440	0	1.78	164.9
	MEAN:	270.4	207.9	#	1.01	93.4

SUMMARY (cont.) :

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)		95% CI	Biomass (lbs/acre)
BRN	42	9	52	±	3.7	0.224	232	±	16.5	43.47
HYB	2	2	4	±	--	0.224	18	±	--	3.08
RBT	63	4	67	±	1.0	0.224	299	±	4.5	137.04

	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)		95% CI	Biomass (kg/ha)
BRN	42	9	52	±	3.7	0.091	571	±	40.7	48.54
HYB	2	2	4	±	--	0.091	44	±	--	3.41
RBT	63	4	67	±	1.0	0.091	736	±	11.0	153.01

	1st Pass	2nd Pass	Pop Est		95% CI	Site Length (mile)	Density (#/mile)		95% CI	Biomass (lbs/mile)
BRN	42	9	52	±	3.7	0.085	612	±	43.5	114.68
HYB	2	2	4	±	--	0.085	47	±	--	8.03
RBT	63	4	67	±	1.0	0.085	788	±	11.8	361.17

CMI
09/29/10
UPSTREAM OF HATCHERY

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	BRN	221	95	0.88	118.1	80.4
1	BRN	211	105	1.12	103.0	101.9
1	BRN	207	95	1.07	97.3	97.6
1	BRN	173	60	1.16	57.2	104.8
1	BRN	168	43	0.91	52.5	82.0
1	BRN	162	32	0.75	47.1	67.9
1	BRN	142	23	0.80	31.9	72.1
1	BRN	129	19	0.89		
1	BRN	126	20	1.00		
1	BRN	117	15	0.94		
1	BRN	116	14	0.90		
1	BRN	116	13	0.83		
1	BRN	115	14	0.92		
1	BRN	114	14	0.94		
1	BRN	111	13	0.95		
1	BRN	110	12	0.90		
1	BRN	106	11	0.92		
1	BRN	106	11	0.92		
1	BRN	105	11	0.95		
1	BRN	104	10	0.89		
1	BRN	103	11	1.01		
1	BRN	103	10	0.92		
1	BRN	102	9.7	0.91		
1	BRN	101	8.5	0.83		
1	BRN	100	8.4	0.84		
1	BRN	98	9.0	0.96		
1	BRN	97	9.4	1.03		
1	BRN	97	8.9	0.98		
1	BRN	96	8.5	0.96		
1	BRN	96	7.7	0.87		
1	BRN	96	7.0	0.79		
1	BRN	96	6.6	0.75		
1	BRN	91	7.5	1.00		
1	BRN	90	6.3	0.86		
1	BRN	85	6.0	0.98		
1	BRN	85	6.0	0.98		
1	BRN	82	5.2	0.94		
1	BRN	82	5.1	0.92		
1	BRN	78	4.0	0.84		
1	BRN	71	3.4	0.95		
1	HYB	236	145	1.10	146.1	99.2
1	HYB	202	80	0.97	90.2	88.7
1	HYB	168	45	0.95	51.0	88.3
1	HYB	76	4.1	0.93		
1	RBT	487	1300	1.13	1270.8	102.3
1	RBT	457	1100	1.15	1048.5	104.9

PASS	SPECIES	LENGTH (mm)	WEIGHT (g)	K	Ws	Wr
1	RBT	432	1300	1.61	884.5	147.0
1	RBT	420	1000	1.35	812.3	123.1
1	RBT	418	1000	1.37	800.6	124.9
1	RBT	406	900	1.34	733.1	122.8
1	RBT	352	460	1.05	476.2	96.6
1	RBT	345	395	0.96	448.1	88.2
1	RBT	275	190	0.91	225.7	84.2
1	RBT	245	150	1.02	159.2	94.2
1	RBT	241	160	1.14	151.4	105.7
1	RBT	235	90	0.69	140.3	64.1
1	RBT	232	145	1.16	135.0	107.4
1	RBT	227	115	0.98	126.4	91.0
1	RBT	227	110	0.94	126.4	87.1
1	RBT	222	130	1.19	118.1	110.0
1	RBT	222	100	0.91	118.1	84.7
1	RBT	222	80	0.73	118.1	67.7
1	RBT	218	110	1.06	111.8	98.4
1	RBT	216	90	0.89	108.7	82.8
1	RBT	215	105	1.06	107.2	97.9
1	RBT	213	105	1.09	104.2	100.7
1	RBT	207	80	0.90	95.6	83.7
1	RBT	207	75	0.85	95.6	78.4
1	RBT	205	75	0.87	92.8	80.8
1	RBT	204	75	0.88	91.5	82.0
1	RBT	197	65	0.85	82.3	79.0
1	RBT	197	65	0.85	82.3	79.0
1	RBT	165	45	1.00	48.2	93.4
2	BRN	203	75	0.90	91.9	81.6
2	BRN	194	50	0.68	80.3	62.2
2	BRN	142	26	0.91	31.9	81.5
2	BRN	128	21	1.00		
2	BRN	123	19	1.02		
2	BRN	120	18	1.04		
2	BRN	115	15	0.99		
2	BRN	108	12	0.95		
2	BRN	105	10	0.86		
2	BRN	91	8.4	1.11		
2	HYB	131	26	1.16	23.6	110.3
2	HYB	80	5.3	1.04		
2	RBT	448	990	1.10	987.3	100.3
2	RBT	256	150	0.89	181.8	82.5
2	RBT	237	145	1.09	144.0	100.7
2	RBT	225	105	0.92	123.0	85.3
2	RBT	223	110	0.99	119.7	91.9
2	RBT	222	110	1.01	118.1	93.1
2	RBT	222	105	0.96	118.1	88.9
2	RBT	216	115	1.14	108.7	105.8
2	RBT	204	80	0.94	91.5	87.5
2	RBT	187	45	0.69	70.3	64.0

SUMMARY:

BRN		LENGTH	WEIGHT	K	Wr
	N:	50	50	50	10
	MIN:	71	3.4	0.68	62.2
	MAX:	221	105	1.16	104.8
	MEAN:	118.7	20.7	0.93	83.2

HYB		LENGTH	WEIGHT	K	Wr
	N:	6	6	6	4
	MIN:	76	4.1	0.93	88.3
	MAX:	236	145	1.16	110.3
	MEAN:	148.8	50.9	1.03	96.6

RBT		LENGTH	WEIGHT	K	Wr
	N:	39	39	39	39
	MIN:	165	45	0.69	64.0
	MAX:	487	1300	1.61	147.0
	MEAN:	265.4	296.7	1.02	93.9

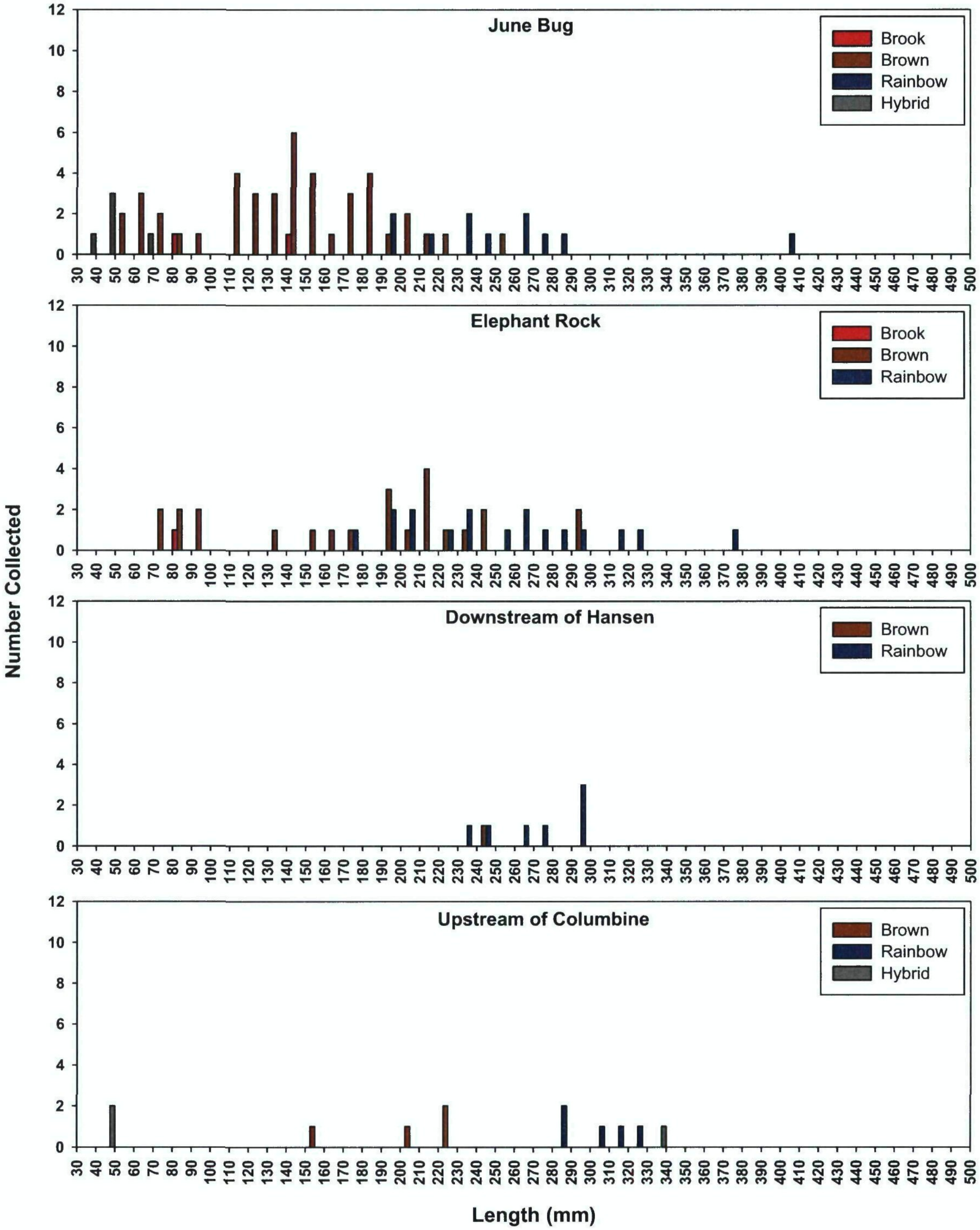
	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	40	10	52	±	5.1	0.148	351	± 34.5	16.02
HYB	4	2	6	±	2.7	0.148	41	± 18.2	4.60
RBT	29	10	42	±	7.3	0.148	284	± 49.3	185.77

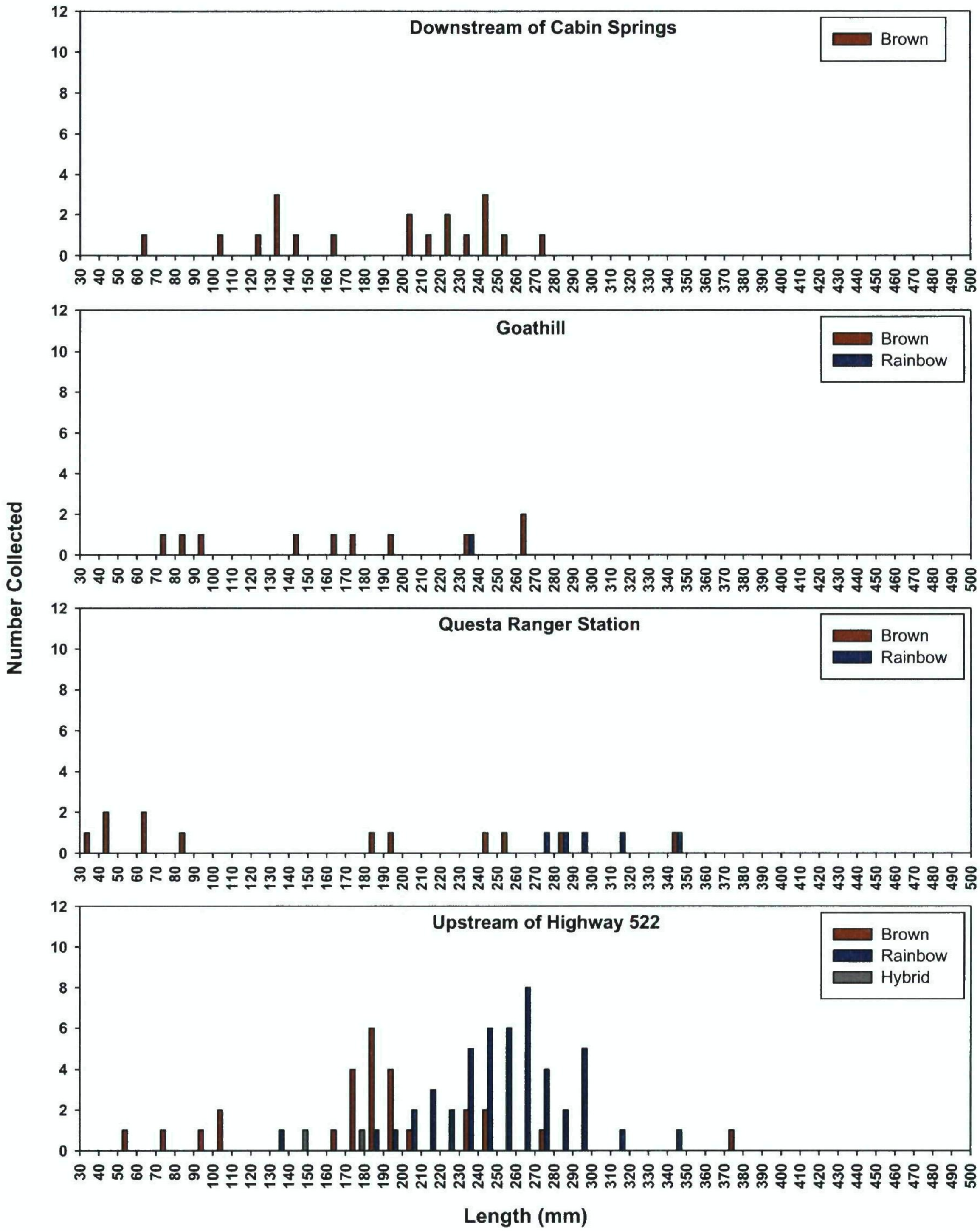
	1st Pass	2nd Pass	Pop Est		95% CI	Site Area (ha)	Density (#/ha)	95% CI	Biomass (kg/ha)
BRN	40	10	52	±	5.1	0.060	867	± 85.0	17.95
HYB	4	2	6	±	2.7	0.060	100	± 45.0	5.09
RBT	29	10	42	±	7.3	0.060	700	± 121.7	207.69

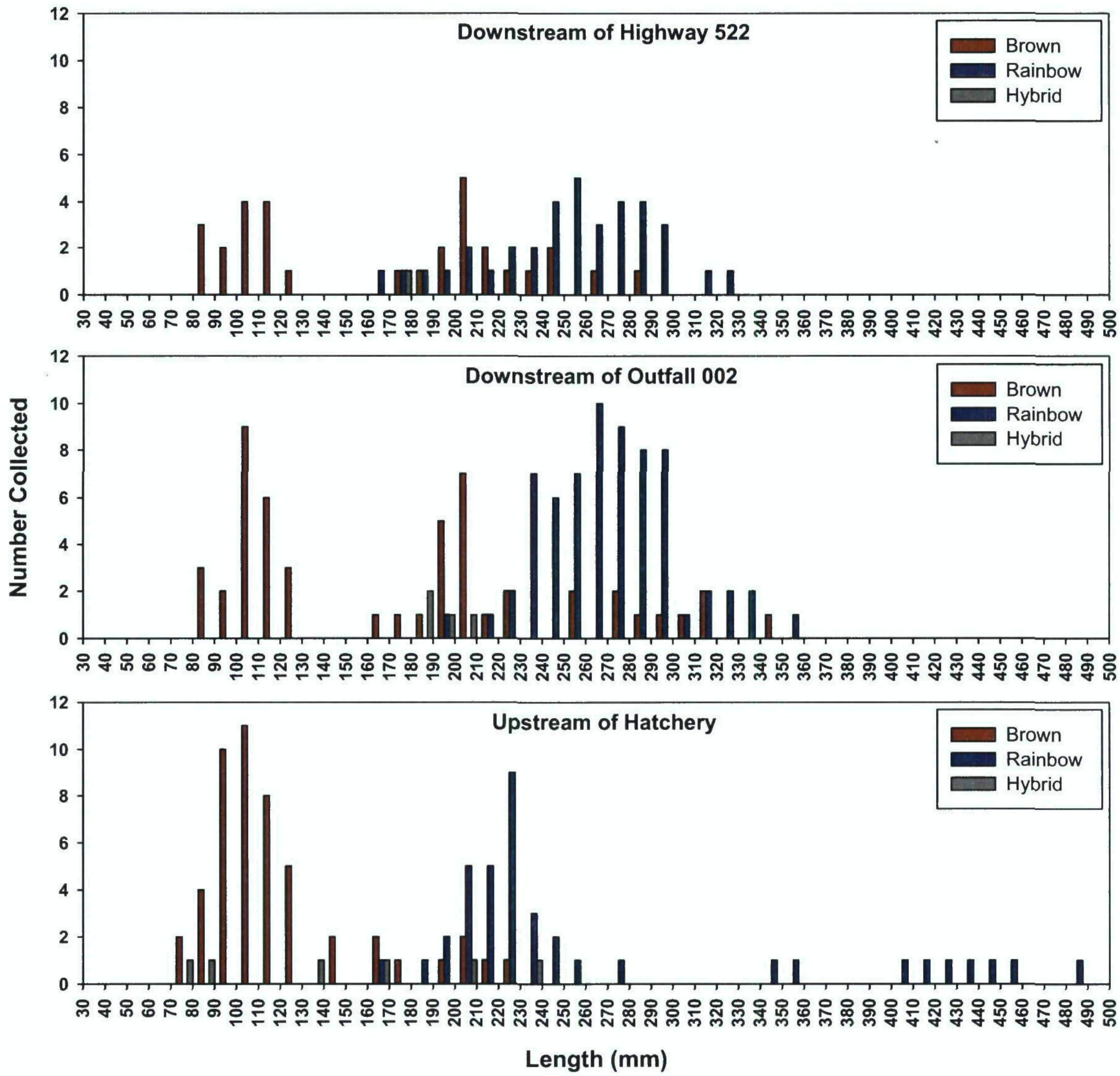
	1st Pass	2nd Pass	Pop Est		95% CI	Site Length	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	40	10	52	±	5.1	0.055	945	± 92.7	43.13
HYB	4	2	6	±	2.7	0.055	109	± 49.1	12.23
RBT	29	10	42	±	7.3	0.055	764	± 132.7	499.74

Appendix B

Fish Length-Frequency Histograms 2010


Number Collected
June Bug
Brook
Brown
Rainbow
Hybrid
Elephant Rock
Brook
Brown
Rainbow
Downstream of Hansen
Brown
Rainbow
Upstream of Columbine
Brown
Rainbow
Hybrid
Length (mm)


Downstream of Cabin Springs
Brown
Goathill
Brown
Rainbow
Questa Ranger Station
Brown
Rainbow
Upstream of Highway 522
Brown
Rainbow
Hybrid
Number Collected
Length (mm)


Downstream of Highway 522
Brown
Rainbow
Hybrid
Downstream of Outfall 002
Upstream of Hatchery
Number Collected
Length (mm)

Appendix C

Benthic Invertebrate Data — Spring and Fall 2010

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: JUNE BUG
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA				**12**		**2**
Unid. Collembola				12		2
EPHEMEROPTERA	**466**	**942**	**396**	**512**	**186**	**500**
Baetis tricaudatus	291	605	256	302	105	312
Drunella grandis	140	174	116	163	58	130
Ephemerella sp.		12	12	47		14
Rhithrogena hageni	35	151	12		23	44
PLECOPTERA	**47**	**47**		**46**	**24**	**32**
Capniidae/Leuctridae		12		23	12	9
Prostoia/Podmosta sp.	47	35		23	12	23
COLEOPTERA	**12**	**35**	**23**	**12**	**23**	**21**
Heterlimnius corpulentus			23	12	23	12
Optioservus sp.		35				7
Zaitzevia parvula	12					2
TRICHOPTERA	**709**	**1140**	**733**	**651**	**1290**	**904**
Arctopsyche grandis	209	465	221	244	395	307
Brachycentrus americanus	442	547	337	244	558	426
Leucotrichia sp.			12			2
Oligophlebodes minutus	58	128	151	151	337	165
Rhyacophila rotunda gr.				12		2
Rhyacophila sibirica gr.			12			2
DIPTERA	**199**	**130**	**60**	**141**	**71**	**119**
Atherix pachypus	12	12				5
Brillia sp.			12			2
Chaetocladius sp.		12	12			5
Diamesa sp.	12			12		5
Dicranota sp.				47		9
Eukiefferiella sp.	58				12	14
Neoplasta sp.	23	23	12	12	35	21
Orthocladius (Euorthocladius)				23		5
Orthocladius/Cricotopus gr.	12	12				5
Unid. Orthocladiinae	23	47	12	12	12	21
Pagastia sp.	12	12				5
Polypedilum sp.	12					2
Psilometriocnemus sp.			12			2
Rheocricotopus sp.	12					2
Simulium sp.	23	12		35	12	16
HYDRACARINA	**93**	**279**	**35**	**128**	**175**	**142**
Lebertia sp.	70	244	35	105	128	116
Sperchon sp.	23			23	12	12
Sperchonopsis sp.		35			35	14
NEMATODA		**23**	**23**		**12**	**12**
Unid. Nematoda		23	23		12	12

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: JUNE BUG
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**12**	**35**	**24**	**23**		**19**
Enchytraeidae	12	23	12	23		14
Nais sp.		12	12			5
POLYCHAETA	**12**					**2**
Aeolosoma sp.	12					2
TOTAL (#/sq. meter)	1550	2631	1294	1525	1781	1753
NUMBER OF TAXA	22	22	19	20	17	38
SHANNON-WEAVER (H')						3.43
TOTAL EPT TAXA	7	9	9	9	8	12
EPT INDEX (% of Total Taxa)	32	41	47	45	47	32
EPHEMEROPTERA ABUNDANCE (% of Total Density)	30	36	31	34	10	29

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: ELEPHANT ROCK
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**768**	**4338**	**2187**	**2128**	**1977**	**2279**
Baetis bicaudatus	105	1512	151	407	70	449
Baetis tricaudatus	314	2268	628	1105	221	907
Drunella doddsi			12	58		14
Drunella grandis	349	558	1396	558	1686	909
PLECOPTERA	**12**	**23**	**12**			**9**
Chloroperlidae	12	23	12			9
COLEOPTERA			**12**		**35**	**9**
Heterlimnius corpulentus			12		35	9
TRICHOPTERA	**233**	**314**	**419**	**442**	**665**	**413**
Arctopsyche grandis					12	2
Brachycentrus americanus	151	291	302	349	512	321
Lepidostoma sp.					12	2
Oligophlebodes minutus					12	2
Rhyacophila hyalinata gr.			12		12	5
Rhyacophila rotunda gr.	70	23	105	93	105	79
Rhyacophila sibirica gr.	12					2
DIPTERA	**338**	**3269**	**1245**	**4677**	**1932**	**2292**
Atherix pachypus	12					2
Brillia sp.			116			23
Cricotopus sp.		430			58	98
Diamesa sp.	23	221				49
Dicranota sp.		12	12	12	12	10
Eukiefferiella sp.	23	430	81	302	128	193
Neoplasta sp.	12		35	35	12	19
Orthocladius (Euorthocladius)	23	221	151	454		170
Orthocladius/Cricotopus gr.	221	1745	768	3187	1710	1526
Unid. Orthocladiinae	12			454		93
Pagastia sp.	12	105		151		54
Pericoma sp.			47			9
Rheocricotopus sp.		105	35			28
Simulium sp.				35	12	9
Tipula sp.				47		9
HYDRACARINA	**81**	**884**	**269**	**884**	**373**	**498**
Lebertia sp.	81	884	233	849	361	482
Sperchon sp.			12			2
Sperchonopsis sp.			12		12	5
Testudacarus/Torrenticola sp.			12	35		9
NEMATODA			**47**			**9**
Unid. Nematoda			47			9

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: ELEPHANT ROCK
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**141**	**384**	**1094**	**2512**	**2163**	**1258**
Enchytraeidae	12	58	47	93	221	86
Lumbriculidae	12					2
Nais bretscheri				81		16
Nais sp.	105	326	1047	2338	1942	1152
Unid. Immature Tubificidae w/ Capilliform Chaetae	12					2
TOTAL (#/sq. meter)	1573	9212	5285	10643	7145	6767
NUMBER OF TAXA	20	17	24	20	20	38
SHANNON-WEAVER (H')						3.42
TOTAL EPT TAXA	7	6	8	6	9	12
EPT INDEX (% of Total Taxa)	35	35	33	30	45	32
EPHEMEROPTERA ABUNDANCE (% of Total Density)	49	47	41	20	28	34

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HANSEN CREEK
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA	**12**					**2**
Podura aquatica	12					2
EPHEMEROPTERA	**338**	**232**	**511**	**350**	**174**	**321**
Baetis bicaudatus	12	35	23	47	58	35
Baetis tricaudatus	163	116	279	163	58	156
Drunella grandis	163	81	209	128	58	128
Rhithrogena hageni				12		2
PLECOPTERA					**35**	**7**
Sweltsa sp.					35	7
COLEOPTERA	**12**	**23**	**12**		**47**	**19**
Heterlimnius corpulentus		23			47	14
Optioservus sp.	12		12			5
TRICHOPTERA	**675**	**535**	**477**	**489**	**1210**	**676**
Arctopsyche grandis			35	12	35	16
Brachycentrus americanus	628	442	372	407	1082	586
Hydropsyche sp.		12				2
Rhyacophila hyalinata gr.	12		12	35	35	19
Rhyacophila rotunda gr.	35	81	58	35	58	53
DIPTERA	**4244**	**5977**	**1523**	**1292**	**7781**	**4162**
Brillia sp.			105			21
Cricotopus sp.	523	186			256	193
Diamesa sp.	267	186		47		100
Dicranota sp.	23	23		47	93	37
Eukiefferiella sp.	128	186	302		256	174
Neoplasta sp.	35	23	23	23	35	28
Orthocladius (Euorthocladius)				47		9
Orthocladius/Cricotopus gr.	3268	5187	1093	1128	6629	3461
Pagastia sp.		186				37
Unid. Orthocladiinae					512	102
HYDRACARINA	**140**	**232**	**291**	**186**	**942**	**358**
Lebertia sp.	128	209	209	186	907	328
Sperchonopsis sp.		23	47			14
Testudacarus/Torrenticola sp.	12		35		35	16

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HANSEN CREEK
Sampled: 4/7/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		**23**	**12**			**7**
Enchytraeidae		23	12			7
TOTAL (#/sq. meter)	5421	7022	2826	2317	10189	5552
NUMBER OF TAXA	16	17	16	14	17	27
SHANNON-WEAVER (H')						2.27
TOTAL EPT TAXA	6	6	7	8	8	10
EPT INDEX (% of Total Taxa)	38	35	44	57	47	37
EPHEMEROPTERA ABUNDANCE (% of Total Density)	6	3	18	15	2	6

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF COLUMBINE
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA	**12**					**2**
Podura aquatica	12					2
EPHEMEROPTERA	**1279**	**837**	**2093**	**721**	**1257**	**1236**
Baetis bicaudatus	407	151	256	81	407	260
Baetis tricaudatus	756	488	1430	512	675	772
Drunella doddsi		12				2
Drunella grandis	35	58	93	105	140	86
Ephemerella dorothea/excrucians			12			2
Rhithrogena hageni	81	128	302	23	35	114
PLECOPTERA	**23**			**12**	**12**	**10**
Pteronarcella badia				12	12	5
Sweltsa sp.	23					5
COLEOPTERA	**12**	**23**			**12**	**9**
Heterlimnius corpulentus	12					2
Optioservus sp.		23			12	7
TRICHOPTERA	**431**	**628**	**628**	**884**	**919**	**698**
Arctopsyche grandis		23	23	12	58	23
Brachycentrus americanus	419	593	593	837	791	647
Oligophlebodes minutus			12	12		5
Rhyacophila rotunda gr.	12	12		23	70	23
DIPTERA	**59**	**35**	**118**	**315**	**94**	**122**
Atherix pachypus	35		35	47	23	28
Brillia sp.		12				2
Dicranota sp.			12			2
Eukiefferiella sp.			12	58		14
Neoplasta sp.	12	23		47	12	19
Orthocladius/Cricotopus gr.	12		12	151	35	42
Unid. Orthocladiinae			23	12	12	9
Polypedilum sp.			12			2
Rhabdomastix sp.					12	2
Rheocricotopus sp.			12			2
HYDRACARINA	**59**	**23**	**128**	**35**	**47**	**58**
Lebertia sp.	35	23	128	23	47	51
Sperchon sp.	12			12		5
Testudacarus/Torrenticola sp.	12					2
NEMATODA		**12**				**2**
Unid. Nematoda		12				2

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF COLUMBINE
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**12**	**12**	**128**	**35**	**70**	**51**
Enchytraeidae		12	70	35	35	30
Nais sp.	12		58		35	21
TOTAL (#/sq. meter)	1887	1570	3095	2002	2411	2188
NUMBER OF TAXA	16	14	18	17	17	31
SHANNON-WEAVER (H')						2.77
TOTAL EPT TAXA	7	8	8	9	8	12
EPT INDEX (% of Total Taxa)	44	57	44	53	47	39
EPHEMEROPTERA ABUNDANCE (% of Total Density)	68	53	68	36	52	56

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF CABIN SPRINGS
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**699**	**1164**	**849**	**1895**	**837**	**1089**
Baetis bicaudatus	105	244	198	465	151	233
Baetis tricaudatus	361	547	465	744	407	505
Drunella doddsi		12	70	47	12	28
Drunella grandis	35	12	23	23	58	30
Rhithrogena hageni	198	349	93	616	209	293
PLECOPTERA	**23**	**24**	**12**	**35**	**24**	**23**
Doddsia occidentalis		12				2
Hesperoperla pacifica			12			2
Prostoia/Podmosta sp.				12	12	5
Pteronarcella badia				23		5
Suwallia sp.	23	12				7
Taenionema sp.					12	2
COLEOPTERA	**35**	**24**		**47**	**35**	**28**
Heterlimnius corpulentus				12	23	7
Narpus concolor	23	12		12	12	12
Optioservus quadrimaculatus	12	12		23		9
TRICHOPTERA	**244**	**489**	**593**	**1361**	**1256**	**788**
Arctopsyche grandis	23	35	186	47	23	63
Brachycentrus americanus	209	454	395	1279	1221	712
Hydropsyche sp.				12		2
Rhyacophila sibirica gr.			12	23	12	9
Rhyacophila sp.	12					2
DIPTERA	**93**	**140**	**82**	**280**	**243**	**169**
Atherix pachypus	23	81	23	105	81	63
Brillia sp.		12	12	58	23	21
Ceratopogoninae	12		12			5
Dicranota sp.		23	23	35	23	21
Eukiefferiella sp.					23	5
Heleniella sp.					23	5
Hesperoconopa sp.	23			12		7
Hexatoma sp.					12	2
Neoplasta sp.	12	12		12	12	10
Orthocladius (Euorthocladius)		12			23	7
Unid. Orthocladiinae				58		12
Polypedilum sp.	23				23	9
Prosimulium sp.			12			2
HYDRACARINA	**12**	**12**	**36**	**24**	**59**	**27**
Lebertia sp.	12	12	12	12	47	19
Protzia sp.			12			2
Sperchon sp.			12			2
Testudacarus/Torrenticola sp.				12		2
Tyrellia sp.					12	2

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF CABIN SPRINGS
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		**12**			**12**	**4**
Nais sp.					12	2
Rhynchelmis sp.		12				2
TOTAL (#/sq. meter)	1106	1865	1572	3642	2466	2128
NUMBER OF TAXA	16	18	17	22	24	39
SHANNON-WEAVER (H')						2.98
TOTAL EPT TAXA	8	9	9	11	10	16
EPT INDEX (% of Total Taxa)	50	50	53	50	42	41
EPHEMEROPTERA ABUNDANCE (% of Total Density)	63	62	54	52	34	51

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: GOATHILL
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**1466**	**767**	**919**	**1164**	**861**	**1036**
Ameletus sp.				12	12	5
Baetis bicaudatus	12			35	12	12
Baetis tricaudatus	35	12	70	186		61
Drunella doddsi		23	12		35	14
Drunella grandis	23	23		93	116	51
Epeorus sp.				12		2
Rhithrogena hageni	1396	709	837	826	686	891
PLECOPTERA	**221**	**58**	**70**	**59**	**59**	**93**
Capnia sp.				12		2
Prostoia/Podmosta sp.			12	12	12	7
Pteronarcella badia	23			35	35	19
Suwallia sp.	198	58	58		12	65
COLEOPTERA	**35**		**35**		**12**	**16**
Narpus concolor	12		23			7
Optioservus sp.	23		12		12	9
TRICHOPTERA	**256**	**151**	**233**	**384**	**1163**	**436**
Arctopsyche grandis	58	23	23	23	70	39
Brachycentrus americanus	174	128	198	302	1058	372
Hydropsyche sp.	12			35		9
Oligophlebodes minutus				12		2
Rhyacophila rotunda gr.	12			12	35	12
Rhyacophila sibirica gr.			12			2
DIPTERA	**199**	**70**	**164**	**352**	**1198**	**396**
Antocha monticola					12	2
Atherix pachypus	105	58	105	128	372	154
Brillia sp.		12			23	7
Chaetocladius sp.			12			2
Cricotopus sp.					23	5
Diamesa sp.				12		2
Dicranota sp.	12		12	12	23	12
Eukiefferiella sp.				12	140	30
Hesperoconopa sp.				12	35	9
Neoplasta sp.	47			105	58	42
Orthocladius (Euorthocladius)				12	47	12
Orthocladius/Cricotopus gr.	23		35	47	419	105
Unid. Orthocladiinae	12			12	23	9
Pagastia sp.					23	5
HYDRACARINA					**151**	**30**
Lebertia sp.					116	23
Sperchonopsis sp.					12	2
Testudacarus/Torrenticola sp.					23	5

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: GOATHILL
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**93**		**23**		**58**	**35**
Enchytraeidae					23	5
Lumbriculidae	23		23		23	14
Nais sp.					12	2
Rhynchelmis sp.	70					14
TOTAL (#/sq. meter)	2270	1046	1444	1959	3502	2042
NUMBER OF TAXA	19	9	15	23	30	40
SHANNON-WEAVER (H')						3.10
TOTAL EPT TAXA	10	7	8	14	11	17
EPT INDEX (% of Total Taxa)	53	78	53	61	37	43
EPHEMEROPTERA ABUNDANCE (% of Total Density)	65	73	64	59	25	51

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: QUESTA RANGER STATION
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**82**	**105**	**116**	**105**	**198**	**120**
Baetis tricaudatus	12	35		12	47	21
Drunella grandis		12		12	23	9
Epeorus sp.					12	2
Rhithrogena hageni	70	58	116	81	116	88
PLECOPTERA	**12**	**12**	**46**		**24**	**18**
Capnia sp.		12				2
Pteronarcella badia	12		23		12	9
Sweltsa sp.			23		12	7
COLEOPTERA	**12**	**46**		**12**	**12**	**16**
Heterlimnius corpulentus		23				5
Narpus concolor		23			12	7
Optioservus divergens	12					2
Zaitzevia parvula				12		2
TRICHOPTERA	**372**	**558**	**652**	**420**	**140**	**428**
Arctopsyche grandis	23	23	58	361	12	95
Brachycentrus americanus	349	523	582		116	314
Lepidostoma sp.				12		2
Rhyacophila sibirica gr.		12	12	47	12	17
DIPTERA	**60**	**187**	**105**	**47**	**47**	**89**
Atherix pachypus	12	47	35	23	23	28
Ceratopogoninae			23			5
Dicranota sp.	12	35	23			14
Ephydridae	12	12			12	7
Hesperoconopa sp.		12	12	12		7
Hexatoma sp.				12		2
Neoplasta sp.	12	23	12		12	12
Orthocladius/Cricotopus gr.	12					2
Unid. Orthocladiinae		58				12
HYDRACARINA			**12**			**2**
Lebertia sp.			12			2
ANNELIDA						
OLIGOCHAETA	**12**					**2**
Enchytraeidae	12					2
TOTAL (#/sq. meter)	550	908	931	584	421	675
NUMBER OF TAXA	12	15	12	10	13	26
SHANNON-WEAVER (H')						2.87
TOTAL EPT TAXA	5	7	6	6	9	11
EPT INDEX (% of Total Taxa)	42	47	50	60	69	42
EPHEMEROPTERA ABUNDANCE (% of Total Density)	15	12	12	18	47	18

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HIGHWAY 522
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2047**	**1279**	**1803**	**1629**	**1639**	**1680**
Baetis bicaudatus	302	337	244	279	174	267
Baetis tricaudatus	686	570	756	733	523	654
Drunella grandis	12		47	47	12	24
Rhithrogena hageni	1047	372	756	570	930	735
PLECOPTERA	**35**	**23**	**35**	**23**	**70**	**37**
Perlodidae	12					2
Pteronarcella badia	23	23	35	23	70	35
COLEOPTERA	**12**		**12**		**12**	**7**
Optioservus quadrimaculatus	12		12		12	7
TRICHOPTERA	**547**	**314**	**174**	**105**	**395**	**307**
Arctopsyche grandis	186	23	58		93	72
Brachycentrus americanus	198	128	58	35	221	128
Hydropsyche sp.	163	163	58	58	81	105
Oligophlebodes minutus				12		2
DIPTERA	**256**	**82**	**339**	**384**	**256**	**263**
Atherix pachypus	81	47	47	70	35	56
Ceratopogoninae				12		2
Eukiefferiella sp.	12		35			9
Hesperoconopa sp.		12	12	35	23	16
Hexatoma sp.	23				12	7
Neoplasta sp.	35		35	58	23	30
Orthocladius (Symposiocladius) lignicola			12			2
Orthocladius (Symposiocladius) sp.				23		5
Orthocladius/Cricotopus gr.	105		174	140	105	105
Unid. Orthocladiinae		23	12	23	35	19
Polypedilum sp.			12		23	7
Rheocricotopus sp.				23		5
HYDRACARINA	**12**	**12**	**23**	**58**		**21**
Lebertia sp.		12	23	58		19
Sperchon sp.	12					2
ANNELIDA						
OLIGOCHAETA		**12**	**12**	**12**		**6**
Enchytraeidae				12		2
Nais bretscheri			12			2
Nais sp.		12				2
TOTAL (#/sq. meter)	2909	1722	2398	2211	2372	2321
NUMBER OF TAXA	16	12	19	18	16	28
SHANNON-WEAVER (H')						2.94
TOTAL EPT TAXA	9	7	8	8	8	10
EPT INDEX (% of Total Taxa)	56	58	42	44	50	36
EPHEMEROPTERA ABUNDANCE (% of Total Density)	70	74	75	74	69	72

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HIGHWAY 522
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA	**12**					**2**
Unid. Collembola	12					2
EPHEMEROPTERA	**2582**	**1582**	**3710**	**1710**	**2571**	**2432**
Baetis bicaudatus	256	140	454	105	430	277
Baetis tricaudatus	733	616	733	640	1082	761
Drunella grandis	35		81	93	140	70
Ephemerella sp.	23					5
Paraleptophlebia sp.		12			12	5
Rhithrogena hageni	1535	814	2442	872	907	1314
PLECOPTERA	**140**	**151**	**140**	**81**	**59**	**114**
Capnia sp.		35				7
Prostoia/Podmosta sp.	23	23	47		12	21
Pteronarcella badia	93	23	81	58	12	53
Suwallia sp.	12	58		23	35	26
Sweltsa sp.	12	12				5
Zapada oregonensis gr.			12			2
COLEOPTERA	**81**	**35**	**93**	**35**	**35**	**56**
Narpus concolor	23		12			7
Optioservus divergens	23	23	23	12	12	19
Optioservus quadrimaculatus	35	12	58	23	23	30
TRICHOPTERA	**407**	**315**	**512**	**640**	**442**	**463**
Arctopsyche grandis	81	58	70	140	93	88
Brachycentrus americanus	209	140	267	267	140	205
Glossosoma sp.		47	12	12	35	21
Hydropsyche sp.	70	35	128	186	116	107
Lepidostoma sp.	23		35	23	35	23
Oligophlebodes minutus	12			12		5
Rhyacophila rotunda gr.	12	35			23	14
DIPTERA	**943**	**537**	**908**	**1256**	**793**	**885**
Atherix pachypus	151	35	151	186	140	133
Ceratopogoninae	140	23	12	12	12	40
Clinocera sp.	12					2
Corynoneura sp.					12	2
Dicranota sp.				23	12	7
Ephydridae		12	35			9
Eukiefferiella sp.	93	35	116	58		60
Heleniella sp.		12				2
Hesperoconopa sp.	47	35	35	23	70	42
Hexatoma sp.	23	35	81	81	70	58
Neoplasta sp.	81	23	35	105	12	51
Orthocladius (Euorthocladius)			12			2
Orthocladius (Symposiocladius) lignicola		12				2
Orthocladius/Cricotopus gr.	384	244	349	768	465	442
Unid. Orthocladiinae	12	47	70			26
Pagastia sp.		12	12			5
Polypedilum sp.		12				2

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HIGHWAY 522
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA	**105**	**35**	**70**	**151**	**175**	**106**
Hygrobates sp.					12	2
Lebertia sp.	105	35	70	81	151	88
Protzia sp.					12	2
Sperchon sp.				23		5
Testudacarus/Torrenticola sp.				47		9
ANNELIDA						
OLIGOCHAETA	**35**	**12**	**35**	**104**		**38**
Enchytraeidae				23		5
Nais sp.	35	12	35	81		33
MOLLUSCA						
GASTROPODA		**12**		**12**		**5**
Fossaria sp.		12		12		5
TOTAL (#/sq. meter)	4305	2679	5468	3989	4075	4101
NUMBER OF TAXA	30	32	28	28	27	48
SHANNON-WEAVER (H')						3.52
TOTAL EPT TAXA	15	14	12	12	14	19
EPT INDEX (% of Total Taxa)	50	44	43	43	52	40
EPHEMEROPTERA ABUNDANCE (% of Total Density)	60	59	68	43	63	59

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF OUTFALL 002
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**4466**	**3907**	**3070**	**5326**	**4675**	**4289**
Baetis bicaudatus	1198	814	302	1663	849	965
Baetis tricaudatus	1791	1430	1535	2419	2477	1930
Drunella grandis	81		47		35	33
Epeorus longimanus		198	47	151		79
Ephemerella dorothea			23		35	12
Paraleptophlebia sp.		35		81		23
Rhithrogena hageni	1396	1430	1116	1012	1279	1247
PLECOPTERA	**396**	**163**	**162**	**302**	**70**	**219**
Isoperla sp.	12		23			7
Prostoia/Podmosta sp.	47	35		81	35	40
Pteronarcella badia	337	47	116	151		130
Suwallia sp.		81	23	35		28
Sweltsa sp.				35	35	14
COLEOPTERA	**174**	**116**	**47**		**58**	**79**
Narpus concolor	81					16
Optioservus divergens		81	12		58	30
Optioservus quadrimaculatus	93	35	35			33
TRICHOPTERA	**3570**	**745**	**1640**	**2058**	**791**	**1761**
Arctopsyche grandis	349	93	163	349		191
Brachycentrus americanus	2128	442	1093	663	500	965
Glossosoma sp.					58	12
Hydropsyche sp.	965	163	326	965	198	523
Lepidostoma sp.	35		23			12
Oligophlebodes minutus	12					2
Rhyacophila coloradensis gr.		12	12		35	12
Rhyacophila rotunda gr.	81	35	23	81		44
DIPTERA	**3338**	**7991**	**3375**	**6502**	**6069**	**5457**
Atherix pachypus	47	116	70	35	151	84
Ceratopogoninae			70	35	58	33
Clinocera sp.		35				7
Cricotopus sp.	93	989				216
Diamesa sp.	93	256	384	198		186
Dicranota sp.	35	35		35	35	28
Eukiefferiella sp.	384		105	198	523	242
Hesperoconopa sp.		116	70		407	119
Hexatoma sp.	35	47	47	151	58	68
Neoplasta sp.	267	198	93	198	151	181
Orthocladius (Euorthocladius)	93	500	105			140
Orthocladius/Cricotopus gr.	2198	5443	2233	5652	4512	4008
Pagastia sp.		256	198		174	126
Tvetenia sp.	93					19
HYDRACARINA	**93**	**186**	**23**	**35**	**163**	**100**
Hygrobates sp.					35	7
Lebertia sp.	93	151	23	35	93	79
Sperchon sp.		35			35	14

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF OUTFALL 002
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
TURBELLARIA	**81**		**116**	**35**	**58**	**58**
Girardia sp.	81		116	35	58	58
NEMATODA		**81**			**93**	**35**
Unid. Nematoda		81			93	35
ANNELIDA						
OLIGOCHAETA	**151**	**395**	**23**	**198**	**58**	**165**
Enchytraeidae	35	81		35	23	35
Limnodrilus sp.	35					7
Nais bretscheri		116				23
Nais sp.	81	163		163	35	88
Unid. Immature Tubificidae w/ Capilliform Chaetae		35				7
Unid. Immature Tubificidae w/o Capilliform Chaetae			23			5
TOTAL (#/sq. meter)	12269	13584	8456	14456	12035	12163
NUMBER OF TAXA	30	33	30	25	28	48
SHANNON-WEAVER (H')						3.50
TOTAL EPT TAXA	13	13	15	13	11	20
EPT INDEX (% of Total Taxa)	43	39	50	52	39	42
EPHEMEROPTERA ABUNDANCE (% of Total Density)	36	29	36	37	39	35

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HATCHERY
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**3244**	**5559**	**1570**	**6140**	**3210**	**3945**
Baetis bicaudatus	488	1349	314	2303	814	1054
Baetis tricaudatus	1465	2326	582	2070	1198	1528
Drunella doddsi				23		5
Drunella grandis	70	140	81	70	116	95
Epeorus longimanus	70	116	23	23	12	49
Paraleptophlebia sp.	221	302	47	651	70	258
Rhithrogena hageni	930	1326	523	1000	1000	956
PLECOPTERA	**151**	**233**	**12**	**419**	**234**	**211**
Isoperla sp.				23	12	7
Pteronarcella badia	81	233	12	186	47	112
Suwallia sp.	70			140	163	75
Sweltsa sp.				47	12	12
Triznaka sp.				23		5
COLEOPTERA	**198**	**233**	**12**	**302**	**82**	**164**
Narpus concolor			12			2
Optioservus divergens	116	140		209	47	102
Optioservus quadrimaculatus	70	93		93	35	58
Zaitzevia parvula	12					2
TRICHOPTERA	**396**	**558**	**128**	**233**	**419**	**346**
Arctopsyche grandis	35	23	35		12	21
Brachycentrus americanus	105	256	35	47	116	112
Hydropsyche sp.	221	186	58	93	209	153
Lepidostoma sp.					12	2
Rhyacophila coloradensis gr.	12				12	5
Rhyacophila rotunda gr.	23	93		93	58	53
DIPTERA	**409**	**581**	**349**	**768**	**630**	**547**
Atherix pachypus	233	198	163	209	326	226
Ceratopogoninae				47	12	12
Diamesa sp.	12	58		47		23
Eukiefferiella sp.	81	58	35	81	81	67
Hesperoconopa sp.	12	23	23		12	14
Hexatoma sp.	12	35	12			12
Neoplasta sp.	12	23		70	12	23
Orthocladius/Cricotopus gr.	35	163	116	233	163	142
Unid. Orthocladiinae	12	23				7
Psilometriocnemus sp.				81	12	19
Simulium sp.					12	2
HYDRACARINA			**12**	**23**		**7**
Lebertia sp.			12	23		7
TURBELLARIA				**23**		**5**
Unid. Turbellaria				23		5
NEMATODA				**93**		**19**
Unid. Nematoda				93		19

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HATCHERY
Sampled: 4/8/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**35**		**35**	**326**	**105**	**100**
Enchytraeidae			12	47		12
Lumbriculidae	23		23	47	58	30
Nais bretscheri				23	12	7
Rhynchelmis sp.	12			209	35	51
TOTAL (#/sq. meter)	4433	7164	2118	8327	4680	5344
NUMBER OF TAXA	26	21	19	31	29	40
SHANNON-WEAVER (H')						3.39
TOTAL EPT TAXA	13	11	10	15	16	18
EPT INDEX (% of Total Taxa)	50	52	53	48	55	45
EPHEMEROPTERA ABUNDANCE (% of Total Density)	73	78	74	74	69	74

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: JUNE BUG
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2849**	**3582**	**2499**	**3257**	**2419**	**2921**
Ameletus sp.				12		2
Baetis bicaudatus	1384	1442	872	1547	1326	1314
Baetis tricaudatus	919	954	698	814	512	779
Drunella doddsi	81	116	58		23	56
Drunella grandis	279	558	430	442	558	453
Epeorus longimanus			23			5
Ephemerella dorothea	81	163	151	70		93
Rhithrogena hageni	105	349	267	372		219
PLECOPTERA	**58**	**23**	**58**	**58**	**116**	**64**
Capniidae	23					5
Cultus aestivalis			23			5
Prostoia besametsa			35	12	23	14
Sweltsa sp.				23	93	23
Taenionema sp.		23				5
Zapada cinctipes	35			23		12
COLEOPTERA	**58**	**93**	**81**	**175**	**70**	**95**
Heterlimnius corpulentus	58	93	81	163	70	93
Narpus concolor				12		2
TRICHOPTERA	**1199**	**1535**	**1512**	**1490**	**2047**	**1556**
Arctopsyche grandis	558	395	756	849	977	707
Brachycentrus americanus	419	721	407	372	698	523
Glossosoma sp.			23			5
Hydropsyche sp.	12			12		5
Lepidostoma sp. B					47	9
Oligophlebodes sp.	186	419	326	233	302	293
Rhyacophila rotunda gr.	12			12		5
Rhyacophila sibirica gr.	12			12	23	9
DIPTERA	**258**	**465**	**406**	**234**	**556**	**385**
Antocha monticola	12		58	12	23	21
Atherix pachypus	12				23	7
Diamesa sp.				12		2
Dicranota sp.	12	23	23	23	93	35
Eukiefferiella sp.	58	93	93	58	81	77
Hexatoma sp.			23	12		7
Limnophila sp.					23	5
Neoplasta sp.		140	35	12	93	56
Orthocladius/Cricotopus gr.	12	23	23	35	81	35
Unid. Orthocladiinae			58	12		14
Pagastia sp.	12	23	35		23	19
Psilometriocnemus sp.	140	140	58	58	116	102
Simulium sp.		23				5
HYDRACARINA	**558**	**559**	**849**	**803**	**907**	**735**
Lebertia sp.	558	512	814	756	884	705
Sperchon/Sperchonopsis sp.		47	35	47	23	30

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: JUNE BUG
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
TURBELLARIA			**58**			**12**
Polycelis coronata			58			12
NEMATODA	**23**	**47**		**12**	**70**	**30**
Unid. Nematoda	23	47		12	70	30
ANNELIDA						
OLIGOCHAETA	**70**	**163**	**209**	**23**	**186**	**130**
Enchytraeidae			35		70	21
Nais sp.	12				93	21
Rhynchelmis sp.	58	163	93	23	23	72
Unid. Immature Tubificidae w/ Capilliform Chaetae			81			16
TOTAL (#/sq. meter)	5073	6467	5672	6052	6371	5928
NUMBER OF TAXA	26	22	29	30	27	45
SHANNON-WEAVER (H')						3.71
TOTAL EPT TAXA	14	10	13	15	11	22
EPT INDEX (% of Total Taxa)	54	45	45	50	41	49
EPHEMEROPTERA ABUNDANCE (% of Total Density)	56	55	44	54	38	49

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: ELEPHANT ROCK
Sampled: 9/27/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**3837**	**2908**	**2233**	**2535**	**3467**	**2997**
Baetis bicaudatus	2140	1396	1093	1163	1791	1517
Baetis tricaudatus	1093	907	733	907	1233	975
Drunella doddsi	23	23	58	12	47	33
Drunella grandis	186	47	128	116	140	123
Rhithrogena hageni	395	535	221	337	256	349
PLECOPTERA	**70**	**139**		**35**	**47**	**59**
Capniidae		23				5
Megarcys signata	35			12		9
Pteronarcella badia				23		5
Sweltsa sp.	35	116			47	40
COLEOPTERA	**116**	**93**	**24**		**23**	**51**
Heterlimnius corpulentus	116	93	12		23	49
Optioservus divergens			12			2
TRICHOPTERA	**511**	**838**	**746**	**698**	**884**	**736**
Arctopsyche grandis	58	233	233	163	163	170
Brachycentrus americanus	314	535	419	488	675	486
Lepidostoma sp. A	23					5
Lepidostoma sp. B			47		23	14
Oligophlebodes sp.	23					5
Rhyacophila hyalinata gr.	93	70	35	47		49
Rhyacophila rotunda gr.			12		23	7
DIPTERA	**1268**	**1117**	**734**	**387**	**1443**	**989**
Ceratopogoninae		47	12		23	16
Diamesa sp.					35	7
Dicranota sp.	12	70	23	12	47	33
Eukiefferiella sp.	337	151	151	47	70	151
Gonomyia sp.	23					5
Limnophila sp.					23	5
Micropsectra sp.		47	35		70	30
Muscidae	23	23				9
Neoplasta sp.	93	23	12	12	47	37
Orthocladius (Symposiocladius) lignicola		23				5
Orthocladius/Cricotopus gr.	35	23	23			16
Unid. Orthocladiinae	35	47	12	12		21
Pagastia sp.	35	47	23	47	174	65
Parametriocnemus sp.			12		70	16
Pericoma sp.	23	23			116	32
Polypedilum sp.					35	7
Prosimulium sp.	23					5
Psilometriocnemus sp.	582	430	105	105	582	361
Simulium sp.	47	140	326	128	93	147
Synorthocladius sp.		23				5
Tipula sp.				12	23	7
Tvetenia sp.				12	35	9
HYDRACARINA	**349**	**140**	**209**	**209**	**325**	**247**
Lebertia sp.	302	140	186	209	302	228
Sperchon/Sperchonopsis sp.	47		23		23	19

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: ELEPHANT ROCK
Sampled: 9/27/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA	**209**	**744**	**23**	**12**		**198**
Unid. Nematoda	209	744	23	12		198
ANNELIDA						
OLIGOCHAETA	**1023**	**744**	**907**	**756**	**7094**	**2105**
Eiseniella tetraedra	23					5
Enchytraeidae	70	23	128			44
Lumbriculidae					465	93
Nais bretscheri			35	23		12
Nais sp.	930	721	744	733	6629	1951
TOTAL (#/sq. meter)	7383	6723	4876	4632	13283	7382
NUMBER OF TAXA	31	29	29	23	30	48
SHANNON-WEAVER (H')						3.57
TOTAL EPT TAXA	12	10	10	10	10	16
EPT INDEX (% of Total Taxa)	39	34	34	43	33	33
EPHEMEROPTERA ABUNDANCE (% of Total Density)	52	43	46	55	26	41

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HANSEN CREEK
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2558**	**1326**	**2256**	**2036**	**2071**	**2049**
Baetis bicaudatus	1430	942	1314	1012	1175	1175
Baetis tricaudatus	802	326	814	779	535	651
Drunella doddsi				12		2
Drunella grandis	302	58	23	163	105	130
Epeorus deceptivus	12					2
Rhithrogena hageni	12		105	70	256	89
PLECOPTERA			**36**	**12**	**48**	**17**
Capniidae			12			2
Cultus aestivalis					12	2
Megarcys signata					12	2
Perlomyia utahensis			12			2
Pteronarcella badia					12	2
Sweltsa sp.			12	12		5
Taenionema sp.					12	2
HEMIPTERA			**12**			**2**
Microvelia sp.			12			2
COLEOPTERA	**58**	**12**	**35**	**47**	**12**	**33**
Heterlimnius corpulentus	23	12		47		16
Narpus concolor	12		35		12	12
Optioservus sp.	23					5
TRICHOPTERA	**1129**	**338**	**477**	**419**	**662**	**604**
Arctopsyche grandis	140	93	314	128	244	184
Brachycentrus americanus	896	198	140	198	395	365
Lepidostoma sp. B				12		2
Oligophlebodes sp.	23	12				7
Rhyacophila hyalinata gr.	70	35	23	81	23	46
DIPTERA	**837**	**139**	**233**	**1338**	**478**	**603**
Diamesa sp.				47		9
Dicranota sp.	58	23			47	26
Eukiefferiella sp.	116		58	372	186	146
Micropsectra sp.			12		12	5
Neoplasta sp.	12	23		70	12	23
Orthocladius/Cricotopus gr.	93			81		35
Unid. Orthocladiinae				47		9
Pagastia sp.	279	35	12	81	23	86
Pericoma sp.	23			35	23	16
Psilometriocnemus sp.	244	58	151	605	163	244
Simuliidae	12					2
Tvetenia sp.					12	2
HYDRACARINA	**536**	**81**	**128**	**210**	**59**	**202**
Aturus/Kongsbergia sp.	12					2
Lebertia sp.	477	81	128	198	47	186
Sperchon/Sperchonopsis sp.	47			12	12	14

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HANSEN CREEK
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA	**93**		**12**	**116**	**93**	**63**
Unid. Nematoda	93		12	116	93	63
ANNELIDA						
OLIGOCHAETA	**152**	**12**	**47**	**152**	**36**	**79**
Enchytraeidae		12		35		9
Lumbriculidae	12		12	12	12	10
Nais bretscheri	12					2
Nais sp.	128		35	105	12	56
Rhynchelmis sp.					12	2
TOTAL (#/sq. meter)	5363	1908	3236	4330	3459	3652
NUMBER OF TAXA	27	14	20	25	26	43
SHANNON-WEAVER (H')						3.41
TOTAL EPT TAXA	9	7	10	10	11	18
EPT INDEX (% of Total Taxa)	33	50	50	40	42	42
EPHEMEROPTERA ABUNDANCE (% of Total Density)	48	69	70	47	60	56

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF COLUMBINE
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2372**	**3349**	**2804**	**2698**	**3443**	**2934**
Baetis bicaudatus	1093	1512	1268	1151	1326	1270
Baetis tricaudatus	1023	1605	1175	1082	1733	1324
Drunella doddsi		58				12
Drunella grandis	186	174	244	221	279	221
Epeorus longimanus			12			2
Rhithrogena hageni	70		105	244	105	105
PLECOPTERA	**12**	**35**	**24**	**81**	**12**	**32**
Capniidae			12			2
Perlomyia utahensis					12	2
Prostoia besametsa				23		5
Pteronarcella badia		35		35		14
Sweltsa sp.	12			23		7
Zapada cinctipes			12			2
COLEOPTERA				**23**	**12**	**7**
Heterlimnius corpulentus				23	12	7
TRICHOPTERA	**116**	**1128**	**373**	**698**	**384**	**539**
Arctopsyche grandis	23	326	140	361	116	193
Brachycentrus americanus	81	616	209	314	221	288
Hydropsyche sp.	12	58	12	23	35	28
Lepidostoma sp. B		35				7
Rhyacophila hyalinata gr.					12	2
Rhyacophila rotunda gr.		93	12			21
DIPTERA	**384**	**2430**	**443**	**455**	**861**	**914**
Antocha monticola		35				7
Atherix pachypus	23			12		7
Ceratopogoninae	12				35	9
Dicranota sp.			12	12	35	12
Eukiefferiella sp.	70	1291	128	35	23	309
Micropsectra sp.				12		2
Neoplasta sp.	35	116	35	35	70	58
Orthocladius/Cricotopus gr.	81	151	12		93	67
Unid. Orthocladiinae	35		23			12
Pagastia sp.					23	5
Pericoma sp.	12			35	12	12
Psilometriocnemus sp.	116	837	233	302	570	412
Stempellina sp.				12		2
HYDRACARINA	**58**	**209**	**140**	**105**	**58**	**114**
Lebertia sp.	58	174	140	105	58	107
Sperchon/Sperchonopsis sp.		35				7
NEMATODA	**93**		**23**	**12**	**35**	**33**
Unid. Nematoda	93		23	12	35	33

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF COLUMBINE
Sampled: 9/30/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**24**	**523**	**325**	**12**	**303**	**237**
Enchytraeidae	12		23		12	9
Nais sp.	12	523	302	12	291	228
TOTAL (#/sq. meter)	3059	7674	4132	4084	5108	4810
NUMBER OF TAXA	20	18	21	22	22	37
SHANNON-WEAVER (H')						3.23
TOTAL EPT TAXA	8	10	11	10	9	18
EPT INDEX (% of Total Taxa)	40	56	52	45	41	49
EPHEMEROPTERA ABUNDANCE (% of Total Density)	78	44	68	66	67	61

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF CABIN SPRINGS
Sampled: 9/27/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2128**	**1349**	**2372**	**1675**	**3407**	**2185**
Baetis bicaudatus	1303	558	1093	826	1512	1058
Baetis tricaudatus	709	488	837	605	930	714
Drunella doddsi		12	12	23	23	14
Drunella grandis	23	105	93	58	12	58
Epeorus longimanus		12				2
Rhithrogena hageni	93	174	337	163	930	339
PLECOPTERA	**36**	**140**	**36**	**24**	**23**	**51**
Cultus aestivalis				12		2
Hesperoperla pacifica		12				2
Perlomyia utahensis	12		12			5
Pteronarcella badia	12	116	12			28
Sweltsa sp.	12		12	12	23	12
Zapada cinctipes		12				2
COLEOPTERA	**23**	**47**	**12**	**24**	**12**	**23**
Heterlimnius corpulentus	23	47	12	12	12	21
Narpus concolor				12		2
TRICHOPTERA	**174**	**1490**	**361**	**477**	**151**	**530**
Arctopsyche grandis	23	663	163	163	23	207
Brachycentrus americanus	151	791	186	279	116	305
Hydropsyche sp.		12	12	23		9
Lepidostoma sp. A		12				2
Rhyacophila sibirica gr.				12	12	5
Rhyacophila sp.		12				2
DIPTERA	**176**	**467**	**420**	**280**	**630**	**393**
Atherix pachypus		70	23	58	81	46
Dicranota sp.				23	47	14
Eukiefferiella sp.	12	163	35			42
Heleniella sp.					12	2
Hexatoma sp.	12					2
Micropsectra sp.		12	12	12	35	14
Neoplasta sp.			35	12	12	12
Orthocladius/Cricotopus gr.		12				2
Unid. Orthocladiinae	12	12				5
Pagastia sp.		12	12	23		9
Pericoma sp.					12	2
Psilometriocnemus sp.	128	105	256	140	419	210
Simulium sp.	12	81	47	12	12	33
HYDRACARINA	**12**	**12**	**12**	**12**	**35**	**16**
Lebertia sp.	12	12			23	9
Sperchon/Sperchonopsis sp.			12	12	12	7
TURBELLARIA		**35**		**23**		**12**
Polycelis coronata		35		23		12

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF CABIN SPRINGS
Sampled: 9/27/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA		**23**	**12**	**35**		**14**
Unid. Nematoda		23	12	35		14
ANNELIDA						
OLIGOCHAETA		**35**	**93**	**24**	**12**	**33**
Enchytraeidae		12		12	12	7
Nais sp.		23		12		7
Rhynchelmis sp.			93			19
TOTAL (#/sq. meter)	2549	3598	3318	2574	4270	3257
NUMBER OF TAXA	16	28	22	25	21	40
SHANNON-WEAVER (H')						3.13
TOTAL EPT TAXA	9	14	11	11	9	18
EPT INDEX (% of Total Taxa)	56	50	50	44	43	45
EPHEMEROPTERA ABUNDANCE (% of Total Density)	83	37	71	65	80	67

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: GOATHILL
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2280**	**2792**	**4338**	**2023**	**1966**	**2680**
Baetis bicaudatus	802	942	1454	465	570	847
Baetis tricaudatus	582	1233	1396	570	640	884
Drunella doddsi	12					2
Drunella grandis	70	163	267	58	70	126
Epeorus longimanus	12		58			14
Rhithrogena hageni	802	454	1163	930	686	807
PLECOPTERA	**24**	**12**	**244**	**36**	**35**	**70**
Capniidae			174	12		37
Perlomyia utahensis			35			7
Pteronarcella badia	12	12	35	12	23	19
Sweltsa sp.	12			12	12	7
COLEOPTERA		**70**	**58**	**47**	**23**	**39**
Heterlimnius corpulentus		35				7
Narpus concolor				12		2
Optioservus divergens		35	58	35	23	30
TRICHOPTERA	**593**	**547**	**1257**	**176**	**443**	**603**
Arctopsyche grandis	209	163	233	12	221	168
Brachycentrus americanus	361	337	989	105	198	398
Glossosoma sp.		12		35	12	12
Lepidostoma sp. B			35	12		9
Oligophlebodes sp.					12	2
Rhyacophila hyalinata gr.	23					5
Rhyacophila rotunda gr.		35		12		9
DIPTERA	**744**	**1106**	**2047**	**942**	**524**	**1074**
Atherix pachypus	81	163	233	93	93	133
Dicranota sp.		35	35			14
Eukiefferiella sp.	23	105	116		12	51
Hexatoma sp.	12	35	35	23		21
Micropsectra sp.		23		23	23	14
Neoplasta sp.		35		23		12
Orthocladius (Symposiocladius) lignicola			58			12
Orthocladius/Cricotopus gr.		163	407	140		142
Parametriocnemus sp.					12	2
Psilometriocnemus sp.	605	547	1163	640	384	668
Tvetenia sp.	23					5
HYDRACARINA	**23**	**81**	**58**	**35**		**39**
Lebertia sp.	23	81	58	35		39
NEMATODA	**12**		**35**		**23**	**14**
Unid. Nematoda	12		35		23	14

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: GOATHILL
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**35**	**35**	**35**	**35**	**23**	**32**
Enchytraeidae	23			23		9
Nais sp.	12	35	35	12	23	23
TOTAL (#/sq. meter)	3711	4643	8072	3294	3037	4551
NUMBER OF TAXA	20	21	22	23	18	35
SHANNON-WEAVER (H')						3.34
TOTAL EPT TAXA	11	9	11	12	10	17
EPT INDEX (% of Total Taxa)	55	43	50	52	56	49
EPHEMEROPTERA ABUNDANCE (% of Total Density)	61	60	54	61	65	59

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: QUESTA RANGER STATION
Sampled: 9/28/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**676**	**1349**	**1453**	**721**	**895**	**1019**
Baetis bicaudatus	198	279	302	302	58	228
Baetis tricaudatus	47	151	93	23	128	88
Drunella grandis	12			12		5
Rhithrogena hageni	419	919	1058	384	709	698
PLECOPTERA	**23**	**24**	**47**	**47**	**140**	**56**
Pteronarcella badia	23	12	47	47	140	54
Sweltsa sp.		12				2
COLEOPTERA			**24**	**58**		**16**
Narpus concolor			12	58		14
Optioservus divergens			12			2
TRICHOPTERA	**12**	**175**	**244**	**314**	**361**	**221**
Arctopsyche grandis		70	70	35	140	63
Brachycentrus americanus		93	151	267	209	144
Hydropsyche sp.	12	12	23	12	12	14
DIPTERA	**198**	**605**	**430**	**791**	**292**	**462**
Atherix pachypus		47		23		14
Ceratopogoninae	12					2
Dicranota sp.		23		12		7
Eukiefferiella sp.	12					2
Hexatoma sp.		12			12	5
Orthocladius/Cricotopus gr.				23	12	7
Psilometriocnemus sp.	174	523	430	733	256	423
Rhabdomastix sp.					12	2
HYDRACARINA	**12**					**2**
Hygrobates sp.	12					2
ANNELIDA						
OLIGOCHAETA	**12**					**2**
Lumbriculidae	12					2
TOTAL (#/sq. meter)	933	2153	2198	1931	1688	1778
NUMBER OF TAXA	11	12	10	13	11	21
SHANNON-WEAVER (H')						2.59
TOTAL EPT TAXA	6	8	7	8	7	9
EPT INDEX (% of Total Taxa)	55	67	70	62	64	43
EPHEMEROPTERA ABUNDANCE (% of Total Density)	72	63	66	37	53	57

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HIGHWAY 522
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**1257**	**1104**	**1350**	**1791**	**1232**	**1346**
Baetis bicaudatus	140	58	140	151	116	121
Baetis tricaudatus	349	221	419	477	279	349
Drunella doddsi			12			2
Drunella grandis	23	81	70		58	46
Paraleptophlebia sp.	12					2
Rhithrogena hageni	733	744	709	1163	779	826
PLECOPTERA		**48**	**35**	**116**	**47**	**48**
Cultus aestivalis		12				2
Perlomyia utahensis		12				2
Pteronarcella badia		12	35	116	47	42
Sweltsa sp.		12				2
COLEOPTERA	**58**	**117**	**58**	**12**	**35**	**56**
Narpus concolor		12			12	5
Optioservus castanipennis	58	105	58	12	23	51
TRICHOPTERA	**372**	**861**	**465**	**1000**	**338**	**607**
Arctopsyche grandis	81	267	128	337	93	181
Brachycentrus americanus	58	163	105	163	140	126
Culoptila sp.				12		2
Glossosoma sp.	23	58	116	23	35	51
Hydropsyche sp.	198	326	116	430	58	226
Lepidostoma sp. A	12	47		35	12	21
DIPTERA	**466**	**872**	**315**	**1011**	**687**	**669**
Atherix pachypus	47	35	58	93	23	51
Ceratopogoninae	12	12	12			7
Cricotopus sp.	12	23		58	70	33
Eukiefferiella sp.	58	128		186	35	81
Hexatoma sp.		23	35	93	47	40
Micropsectra sp.	23	23		23	23	18
Neoplasta sp.	35	70	47	23	35	42
Orthocladius/Cricotopus gr.	70	314	70	256	221	186
Unid. Orthocladiinae		23				5
Pagastia sp.	23	58		81		32
Pericoma sp.				12		2
Psilometriocnemus sp.	163	151	93	186	233	165
Simuliidae		12				2
Tvetenia sp.	23					5
HYDRACARINA		**70**	**24**		**58**	**30**
Lebertia sp.		35	12		35	16
Sperchon/Sperchonopsis sp.		35	12		23	14
NEMATODA		**23**				**5**
Unid. Nematoda		23				5

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HIGHWAY 522
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		**35**	**24**		**58**	**23**
Enchytraeidae		23			23	9
Nais bretscheri		12	12		12	7
Nais sp.			12		23	7
TOTAL (#/sq. meter)	2153	3130	2271	3930	2455	2784
NUMBER OF TAXA	21	32	21	21	25	38
SHANNON-WEAVER (H')						3.73
TOTAL EPT TAXA	10	13	10	10	10	16
EPT INDEX (% of Total Taxa)	48	41	48	48	40	42
EPHEMEROPTERA ABUNDANCE (% of Total Density)	58	35	59	46	50	48

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HIGHWAY 522
Sampled: 9/28/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**1604**	**2314**	**2582**	**2489**	**2943**	**2387**
Baetis bicaudatus	93	186	140	93	151	133
Baetis tricaudatus	744	942	768	954	1198	921
Drunella grandis	23	58	81	35	47	49
Paraleptophlebia sp.	23	12				7
Rhithrogena hageni	721	1116	1593	1407	1547	1277
PLECOPTERA	**59**	**151**	**47**	**140**	**94**	**97**
Capniidae					12	2
Pteronarcella badia	47	70	35	93	47	58
Sweltsa sp.	12	81	12	47	35	37
COLEOPTERA	**23**	**116**	**93**	**104**	**116**	**90**
Narpus concolor		23		23		9
Optioservus divergens	23	93	93	81	116	81
TRICHOPTERA	**314**	**606**	**768**	**721**	**582**	**597**
Arctopsyche grandis	93	140	174	81	35	105
Brachycentrus americanus	58	128	116	105		81
Culoptila sp.		23	70	23		23
Glossosoma sp.		12	128	174	407	144
Hydropsyche sp.	128	291	256	314	93	216
Lepidostoma sp. A	23	12	12	12	35	19
Rhyacophila hyalinata gr.				12		2
Rhyacophila sp.	12		12		12	7
DIPTERA	**641**	**802**	**826**	**629**	**1105**	**802**
Atherix pachypus	70	105	47	23	93	68
Brillia sp.	12					2
Ceratopogoninae				12	12	5
Cricotopus sp.	12			12		5
Eukiefferiella sp.	140	116	209	186	279	186
Hexatoma sp.	23	47	35		70	35
Micropsectra sp.	35	174				42
Neoplasta sp.	23	35	35	12	105	42
Orthocladius/Cricotopus gr.	198	116	465	291	384	291
Pagastia sp.				12	58	14
Polypedilum sp.		23				5
Psilometriocnemus sp.	93	128	23	58	58	72
Simulium sp.	23	58	12	23		23
Synorthocladius sp.					23	5
Tvetenia sp.	12				23	7
HYDRACARINA	**12**	**35**	**12**		**12**	**14**
Lebertia sp.	12	35				9
Sperchon/Sperchonopsis sp.			12		12	5

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF HIGHWAY 522
Sampled: 9/28/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		**36**				**6**
Enchytraeidae		12				2
Nais bretscheri		12				2
Nais sp.		12				2
TOTAL (#/sq. meter)	2653	4060	4328	4083	4852	3993
NUMBER OF TAXA	25	28	22	24	24	38
SHANNON-WEAVER (H')						3.39
TOTAL EPT TAXA	12	13	13	13	12	16
EPT INDEX (% of Total Taxa)	48	46	59	54	50	42
EPHEMEROPTERA ABUNDANCE (% of Total Density)	60	57	60	61	61	60

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF OUTFALL 002
Sampled: 9/28/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**2513**	**2373**	**2058**	**1582**	**1744**	**2055**
Baetis bicaudatus		70	35	23		26
Baetis tricaudatus	1326	1047	1023	733	1035	1033
Drunella grandis	233	279	116	140	116	177
Rhithrogena hageni	954	977	884	686	593	819
PLECOPTERA	**209**	**151**	**35**	**12**	**256**	**133**
Isoperla sp.	23					5
Pteronarcella badia	186	116	12	12	244	114
Sweltsa sp.		35	23		12	14
COLEOPTERA	**581**	**488**	**245**	**163**	**291**	**353**
Narpus concolor		35	12			9
Optioservus castanipennis	209	151	70	58	93	116
Optioservus divergens	372	302	163	105	198	228
TRICHOPTERA	**2279**	**734**	**478**	**779**	**989**	**1052**
Arctopsyche grandis	256	128	70	209	198	172
Brachycentrus americanus	1116	128	151	314	337	409
Glossosoma sp.		12	47	12	12	17
Hydropsyche sp.	861	419	198	244	442	433
Lepidostoma sp. A	23	35				12
Rhyacophila rotunda gr.	23	12	12			9
DIPTERA	**2001**	**779**	**988**	**1270**	**1127**	**1232**
Atherix pachypus	93	116	116	140	151	123
Ceratopogoninae		12		12		5
Diamesa sp.		93	163	35	23	63
Eukiefferiella sp.	1163	267	326	698	465	584
Hesperoconopa sp.	23				12	7
Hexatoma sp.	47	35	23	35		28
Limnophila sp.				12		2
Micropsectra sp.				35		7
Neoplasta sp.	116	35	47	35	116	70
Orthocladius/Cricotopus gr.	512	35	244	221	23	207
Unid. Orthocladiinae			23		23	9
Pagastia sp.		81	23	35	58	39
Psilometriocnemus sp.	47	93	23		256	84
Simulium sp.				12		2
Zavrelimyia sp.		12				2
HYDRACARINA	**47**	**12**	**12**	**12**	**24**	**22**
Lebertia sp.	47				12	12
Sperchon/Sperchonopsis sp.		12	12	12	12	10
TURBELLARIA	**186**	**140**	**23**	**70**	**47**	**93**
Girardia sp.	186	105	23	70	35	84
Polycelis coronata		35			12	9
NEMATODA		**35**				**7**
Unid. Nematoda		35				7

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: DOWNSTREAM OF OUTFALL 002
Sampled: 9/28/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	**140**	**12**	**104**	**47**	**59**	**72**
Nais bretscheri	93		23	12	12	28
Nais sp.	47	12	81	35	47	44
HIRUDINEA					**12**	**2**
Glossiphonia complanata					12	2
TOTAL (#/sq. meter)	7956	4724	3943	3935	4549	5021
NUMBER OF TAXA	23	30	27	26	27	39
SHANNON-WEAVER (H')						3.82
TOTAL EPT TAXA	10	12	11	9	9	13
EPT INDEX (% of Total Taxa)	43	40	41	35	33	33
EPHEMEROPTERA ABUNDANCE, (% of Total Density)	32	50	52	40	38	41

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HATCHERY
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
EPHEMEROPTERA	**1036**	**2058**	**2931**	**2129**	**2873**	**2205**
Baetis bicaudatus	70	105	302	151	163	158
Baetis tricaudatus	256	558	1524	1082	907	865
Cinygmula par	12					2
Drunella grandis	12	23	35	81	93	49
Paraleptophlebia sp.			12	47	70	26
Rhithrogena hageni	686	1372	1058	768	1640	1105
PLECOPTERA	**47**	**35**	**71**	**71**	**221**	**89**
Capniidae	12					2
Perlomyia utahensis			12	12		5
Pteronarcella badia		35	12	47	221	63
Sweltsa sp.	35		47	12		19
COLEOPTERA	**186**	**326**	**477**	**512**	**267**	**353**
Narpus concolor	35	12	47	47		28
Optioservus castanipennis	151	314	430	465	267	325
TRICHOPTERA	**360**	**465**	**735**	**1025**	**978**	**712**
Arctopsyche grandis		23	47		93	33
Brachycentrus americanus	116	105	47	105	35	82
Culoptila sp.	23	58	12	47	47	37
Glossosoma sp.			35	12		9
Hydropsyche sp.	198	267	582	814	791	530
Lepidostoma sp. A	23			12		7
Rhyacophila hyalinata gr.		12	12		12	7
Rhyacophila sp.				35		7
DIPTERA	**304**	**559**	**733**	**1116**	**897**	**721**
Atherix pachypus	116	209	349	337	337	270
Ceratopogoninae	12		12	12	12	10
Diamesa sp.					12	2
Eukiefferiella sp.	93	186	209	395	326	242
Hexatoma sp.	12	12		12		7
Limnophila sp.				35		7
Neoplasta sp.					12	2
Orthocladius (Euorthocladius)	12					2
Orthocladius/Cricotopus gr.	35		35	35		21
Unid. Orthocladiinae		12				2
Pagastia sp.	12		12			5
Polypedilum sp.		35	35	23		19
Psilometriocnemus sp.		93	81	186	81	88
Simulium sp.	12	12		81	105	42
Tvetenia sp.					12	2
HYDRACARINA		**35**		**35**		**14**
Lebertia sp.		12				2
Sperchon/Sperchonopsis sp.		23		35		12
NEMATODA		**23**	**12**	**35**		**14**
Unid. Nematoda		23	12	35		14

MACROINVERTEBRATE DENSITY
Client: CHEVRON MINING INC.
Site: UPSTREAM OF HATCHERY
Sampled: 9/29/2010

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		**35**	**82**	**128**	**24**	**53**
Nais bretscheri				128	12	28
Nais sp.		23	47		12	16
Rhynchelmis sp.		12	35			9
TOTAL (#/sq. meter)	1933	3536	5041	5051	5260	4161
NUMBER OF TAXA	21	24	26	28	22	41
SHANNON-WEAVER (H')						3.44
TOTAL EPT TAXA	11	10	14	14	11	18
EPT INDEX (% of Total Taxa)	52	42	54	50	50	44
EPHEMEROPTERA ABUNDANCE (% of Total Density)	54	58	58	42	55	53